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POWER

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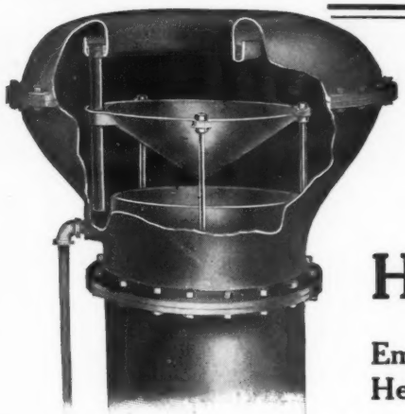

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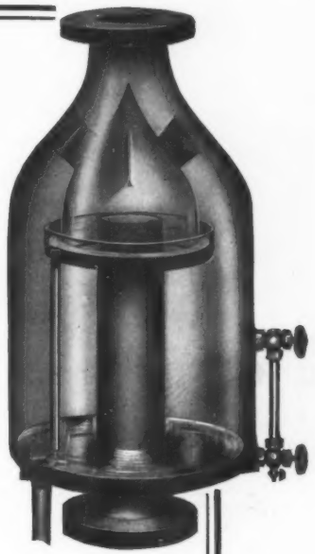

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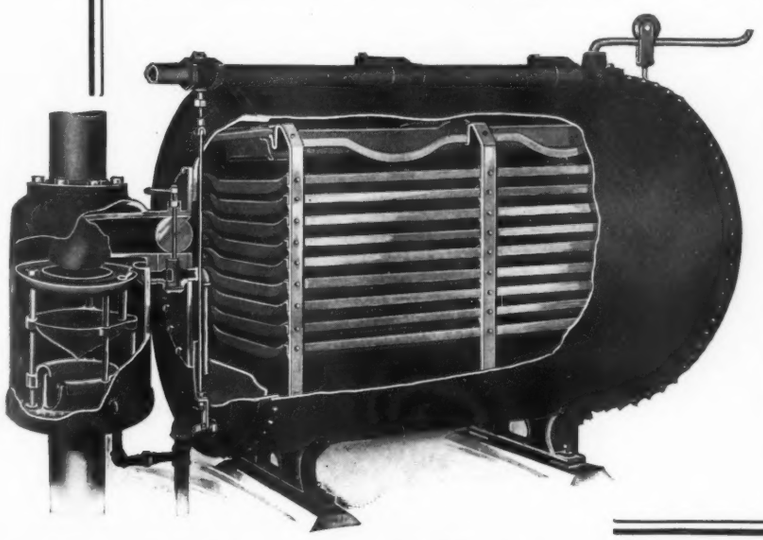

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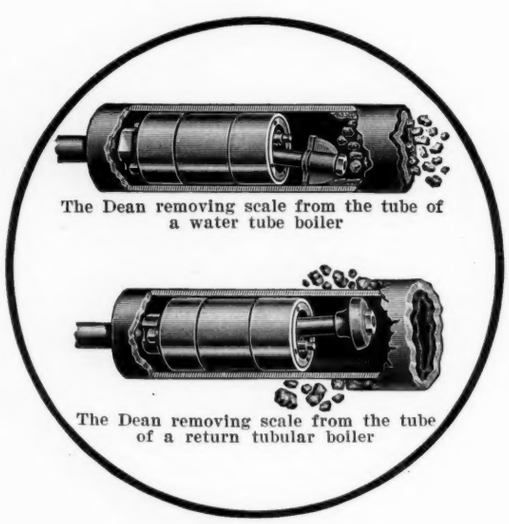

The Dean removing scale from the tube of a water tube boiler

The Dean removing scale from the tube of a return tubular boiler

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POWER

NEW YORK, MARCH 14, 1911

SOME months ago there was a cartoon on this page showing that while the engineer was dozing over his work the central-station solicitor was busy and succeeded in getting public-service wires into the building.

To those who saw the picture it was just as evident that the heating company had also got a foothold, and its steam-supply pipe was just as ready for service as the electric wires.

But the picture told more than this.

It told how the wires from the central station and the pipe from the steam heating company found an opening through which the building could be entered. It was made by the engineer himself while asleep on duty.

He walked about in his sleep, attending to the routine work of the plant and nothing else. Neglect and mental indolence so clouded his brain that the invasion of his field was not noticed until it was too late. Another engineer went out into the world to enter the ranks of the unemployed and by his competition help to force still lower the standard of wages and living of that class of skilled workmen whose remuneration should be the highest paid to any workers in the country.

But he slept. His obvious duties were perfunctorily performed, while the more important factors of his vocation were neglected.

He knew how to shovel coal enough into the furnace to generate what steam was wanted. But he did not know whether he was using too much for the work or only enough.

He knew when he saw the switchboard how much current was being used at that moment. But he did not know how much that current cost per kilowatt-hour.

He knew how to read the water meter through which the water went to the feed pump. But he did not know whether leaking steam valves and pistons in pump and engine were wasting a third of the water that went to the boiler.

He could attend with apparent skill and intelligence to every detail in the operation of the plant. But when the proprietor showed him the central-station and the heating-plant figures, and asked if he could meet them with the present equipment, he was dumb.

He had been sleeping on the job in fancied security, while the men who wanted his plant were awake and busy.

They knew how much coal was burned, the amount of the water bill and the size of the payroll for this department. It was all, every item, on the tips of the solicitors' glib tongues. They could tell the owner everything; he nothing.

It is certain that the immediate interests of a greater number of people will be better served by the use of isolated plants for heat, light and power in a great majority of modern office, store and apartment buildings. But to continue in service those already installed and add to their number as buildings are erected, the engineer must be the character implied by the name: alert, intelligent, courageous, aggressive and, above all, a master in his vocation.

Everybody is ready to help the bottom dog in a fight if he fights. While but few have either respect or sympathy for a "quitter."

New Power Plant of Amoskeag Mills

By Warren O. Rogers

This plant contains sixty-four 300-horsepower Manning boilers set in a single row in a boiler room 500 feet long. The boilers consume 130,000 tons of coal per year and supply steam to 42,300 horsepower of engine equipment and for manufacturing purposes.

The Amoskeag Manufacturing Company, Manchester, N. H., employs 15,000 men and women, and uses 50,000,000 pounds of cotton and 15,300,000 pounds of wool per year. This requires 65,700 nominal boiler horsepower and 42,300 engine horsepower, of which 17,500 horsepower is developed by steam turbines. The steam necessary to operate these engines in addition to that used in the process of manufacture demands an annual consumption of 130,000 tons of coal.

When present plans are completed, the power necessary to drive the machinery in these mills, and the steam used for other purposes, will be generated in three central power plants, dividing the mills into three sections, each section having its own central station. Two of these power plants have been running for several years, but the third is just being put into use.

The initial idea, when the new plant was proposed, was to furnish power for the new Coolidge mill, built on the opposite side of the river. This mill requires about 4000 horsepower; the machinery is motor driven and the electrical current is carried across the river by means of wires supported by towers placed on an island in the center of the river and on the two banks. The wires start from the wire tower above the switchboard.

Steam Turbines

This new power plant contains two of the first horizontal type of Curtis turbines made, each of 3500 kilowatts capacity. They are set side by side at one end of the turbine room, as shown in Fig. 3, on a concrete foundation that is built on a solid ledge base. There is room enough between the turbines and the end wall of the building for the switchboard gallery, and enough floor room has been provided for several more turbines, should they be required. The turbines under a steam pressure of 175 pounds per square inch run at a speed of 1200 revolutions per minute.

Fig. 1. Cleaning Side of the Manning Boilers. The Hand Lever in Front of Each Boiler Controls the Air Supply in the Air Duct

Although rated at 3500 kilowatts, each unit will be made to develop 6000 kilowatts continuously, or nearly double the rated capacity of the machne. Each generator is kept cool by means of a fan blower attached directly to the turbine shaft. Air is taken from the turbine room and discharged into the room again through the top of the generator casing.

FIG. 2. THE SIXTY-FOUR MANNING BOILERS EQUIPPED WITH JONES STOKERS

CONDENSERS

Each turbine is piped to a Bulkley type of condenser, and each head has three condensing nozzles arranged as shown in Fig. 4. No circulating pump is used, as the condensers are started and operated by the condensing water itself and a vacuum of from 26 to 27 inches is maintained.

A 57-inch flume conveys the condensing water from a point above a dam in the Merrimac river to the basement under the turbine room, and the drop of the pipe permits of a 32-foot head at the lower end. Each discharge tube of three jet nozzles is fitted with a starting or priming pipe. As the lift of the condensing water is but 2 feet, the water in flowing from the priming pipe to the discharge pipe of the jet head creates enough vacuum to lift the condensing water, which, when once started, maintains a steady flow to the condenser. The water of condensation and cooling water is allowed to go to waste to the river, there being no economy in saving it. The feed water is heated by the exhaust steam from the feed pumps and auxiliaries in a closed heater after which it passes

through economizers. The condensers are set outside of the turbine room and discharge into a hotwell from which the water runs to the river.

There is fitted, at the top of each condenser, an atmospheric exhaust pipe. When first installed these condensers gave trouble at starting, because of water backing up in the cone chamber and flooding back into the turbine exhaust pipe. The cones were removed and bored out from 6½ to 7½ inches in diameter, which increased the opening in them 40 per cent. A piece of 48-inch pipe, the size of the exhaust pipe leading from the turbines, 6 feet 6 inches long, was inserted between the top head of the condenser and the main riser pipe. A similar length of pipe was also inserted in each of the pipes leading from the head to the nozzles. These changes eliminated the trouble as the water must now lift 11 feet before it can overflow into the exhaust pipe. Fig. 4 shows the former and present arrangement of the condensers. The cooling water is controlled by three valves in the supply pipes which are located in the turbine room.

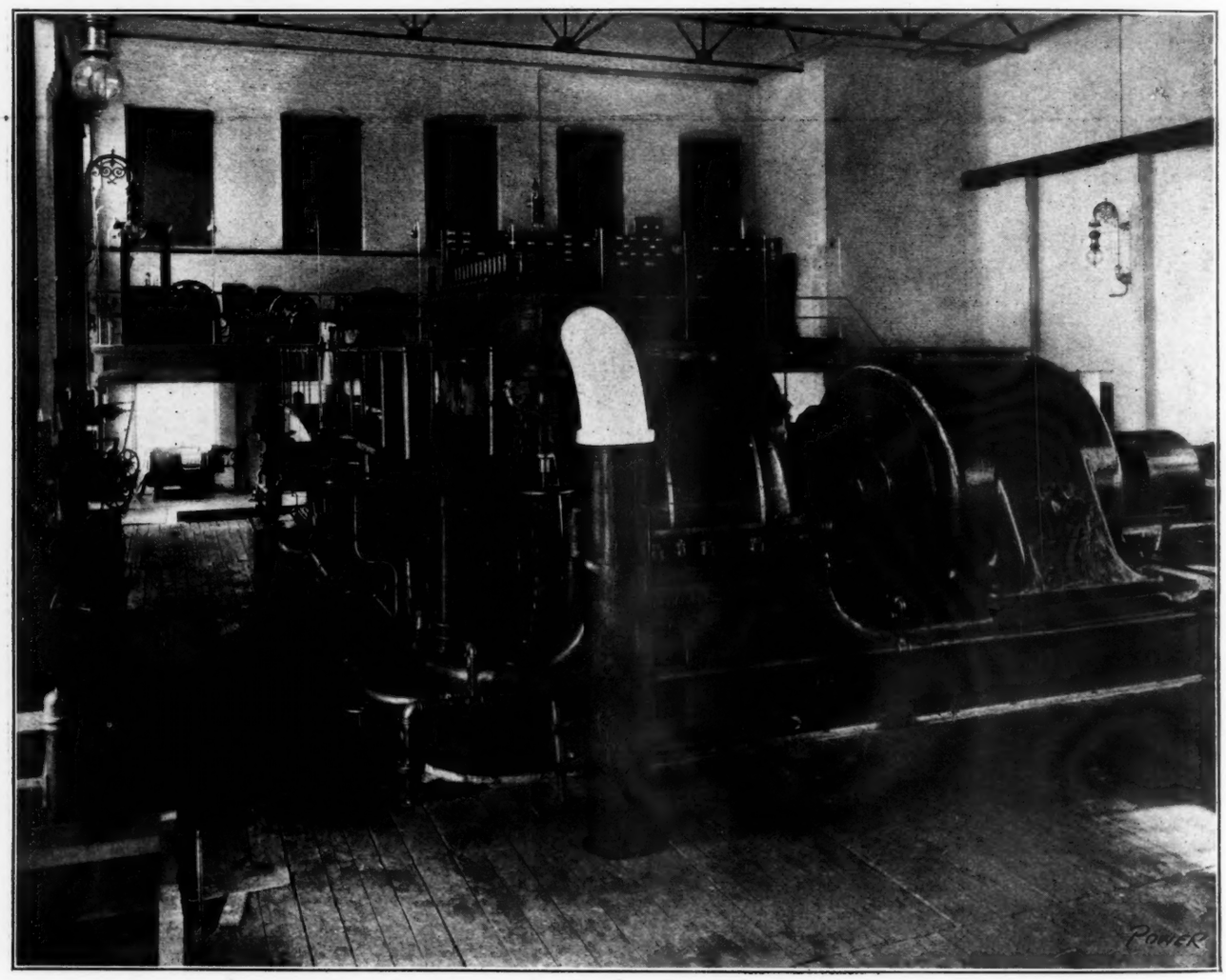


FIG. 3. VIEW OF THE TWO 3500-KILOWATT HORIZONTAL CURTIS TURBINES. THE PERMANENT FLOOR HAS NOT YET BEEN LAID

PIPING

The steam pipe leading to each turbine is 12 inches in diameter, and branches from a 20-inch main leading from the boiler room. All steam pipes are placed in the basement under the turbine room, the 20-inch main rising to a level with the top of the boilers after it has passed to a point under the pump-room floor. Owing to the large exposed surface of the exhaust pipe of each turbine, considerable condensation takes place at light loads of 1500 kilowatts or under, and in order to keep these exhaust pipes free of water a Strong vacuum trap is used on one and a receiving tank and duplex steam pump on the other. Fig. 6 is a cross-sectional view of the turbine room and also shows the arrangement of the condensers.

EXCITERS

On the switchboard platform there are two motor-driven exciter sets of General Electric make and on the ground floor is a turbine-driven set which is used as an emergency unit. There is also a motor-driven direct-current generator which supplies current at 250 volts to the motors operating the coal-hoisting and conveying machinery.

The switchboard is of slate and contains the necessary apparatus to control the electrically operated oil switches, which are placed on the turbine floor directly beneath the switchboard. The feeder cables drop from the switches to iron-pipe conduits, suspended from the ceiling of the basement, and are carried to the various points of distribution through iron-pipe conduits set in concrete piers. These iron conduits, after they leave the cement piers, are encased in concrete work, which extends from the power plant to the nearest factory building.

BOILER ROOM

The boiler room is worth going some distance to see, for it is not often that one can view 64 boilers set in a single row in a boiler room 500 feet long. These Manning boilers are each of 300 horsepower capacity, or a total of 19,200 horsepower. They are set in four batteries of 16 boilers and each battery is con-

nected to a separate smoke flue. Figs. 1 and 2 show the cleaning and stoker sides of the boilers.

Beginning at either end of the boiler room, the brick-lined smoke flue extends the length of the first battery of 16 boilers and at a hight that will permit the smoke connection from each boiler to be made above the center line of the flue. The flue from each end battery then rises to permit the flue from each middle battery to form the lower half of a double smoke flue, which carries the gases to the stack, located outside and midway of the building. The smoke flue from each boiler is provided with a damper which is kept open while that boiler is in operation.

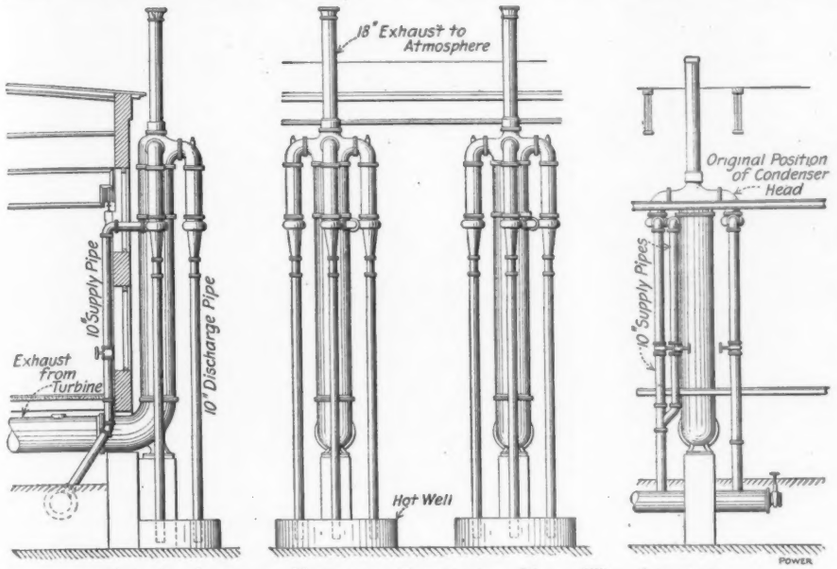


FIG. 4. SHOWING HOW THE CONDENSER HEAD WAS ALTERED

FORCED DRAFT

Forced draft is used, and each battery of boilers is supplied with air by an 8-foot 6-inch fan blower driven by an 8x10-inch Sturtevant engine. The air is driven through a duct to the main air duct that extends the entire length of the battery which the blower is serving. A branch duct conveys the air to each boiler. The air is controlled by a swinging damper, one for each boiler, which is regulated by a hand lever attached to an extension rod and placed convenient for the fireman to operate.

The steam pipe of the blower engine is fitted with a Foster reducing valve to control the speed of the engine, shutting off the steam as the pressure in the boilers increase and admitting the steam as the pressure decreases. With this means

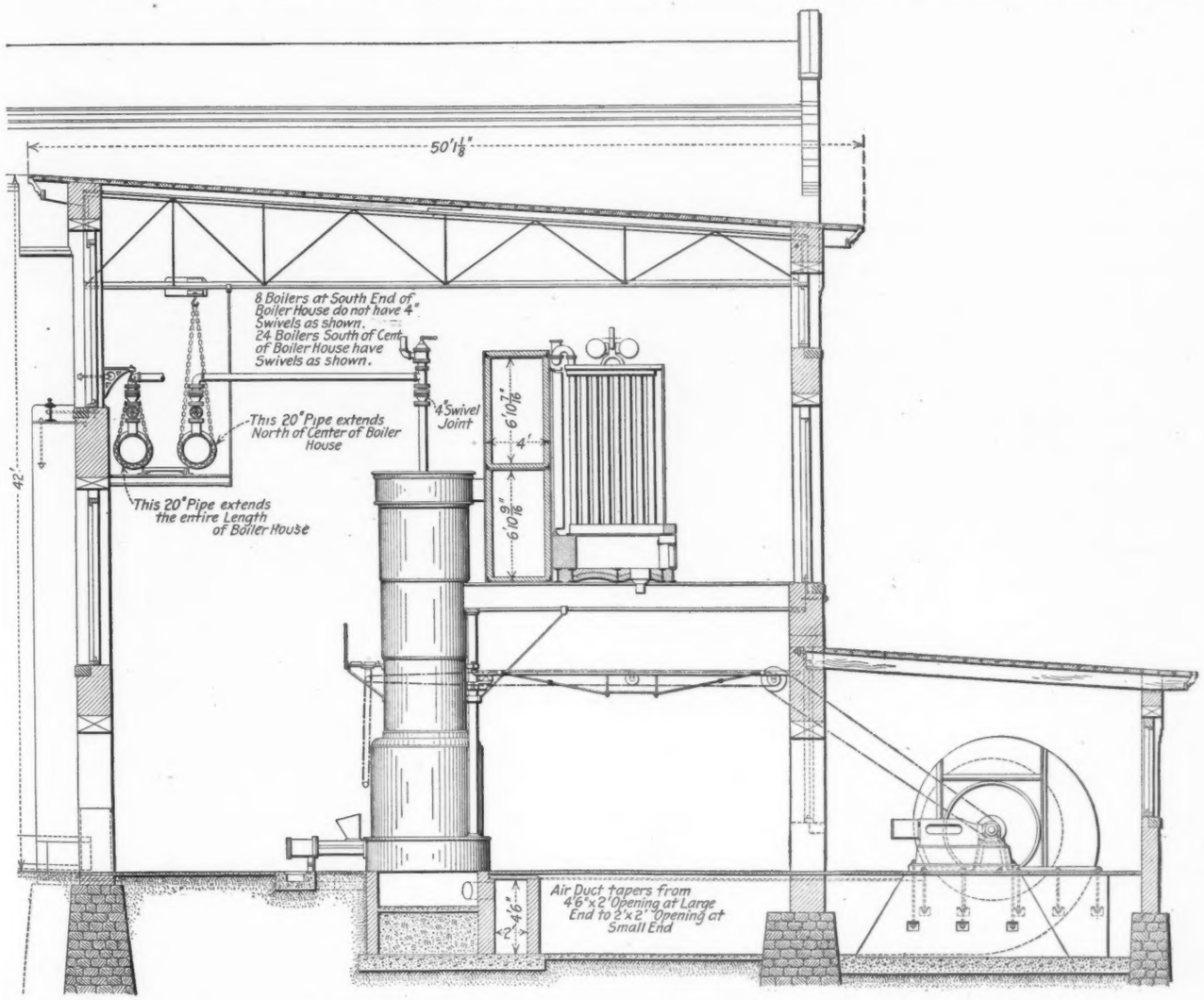

50'1⅛"
8 Boilers at South End of Boiler House do not have 4" Swivels as shown. 24 Boilers South of Cent. of Boiler House have Swivels as shown.
This 20" Pipe extends North of Center of Boiler House
This 20" Pipe extends the entire Length of Boiler House
4" Swivel Joint
6'10⅞"
4'
6'10⅞"
42'
2'4½"
Air Duct tapers from 4'6"x2'0" Opening at Large End to 2'x2'0" Opening at Small End

FIG. 5. CROSS-SECTIONAL VIEW OF THE BOILER AND BLOWER ROOMS

of draft regulation, the variation in steam pressure is between three and four pounds.

Stokers

The apparatus controlling the steam valves that admit steam to the cylinders of the Jones stokers for each battery of boilers, is driven from a cam shaft by means of sprocket wheels and a chain belt. As the speed of the fan decreases the speed of the stoker apparatus is decreased; when the pressure drops the speed of fan and stoker increase. With the blower engine running at full speed the stokers feed once per minute, but with a slow-speed and high-steam pressure the stokers feed but once in four minutes. Usually the stokers do not feed at all during the period that the blower engine is running at reduced speed.

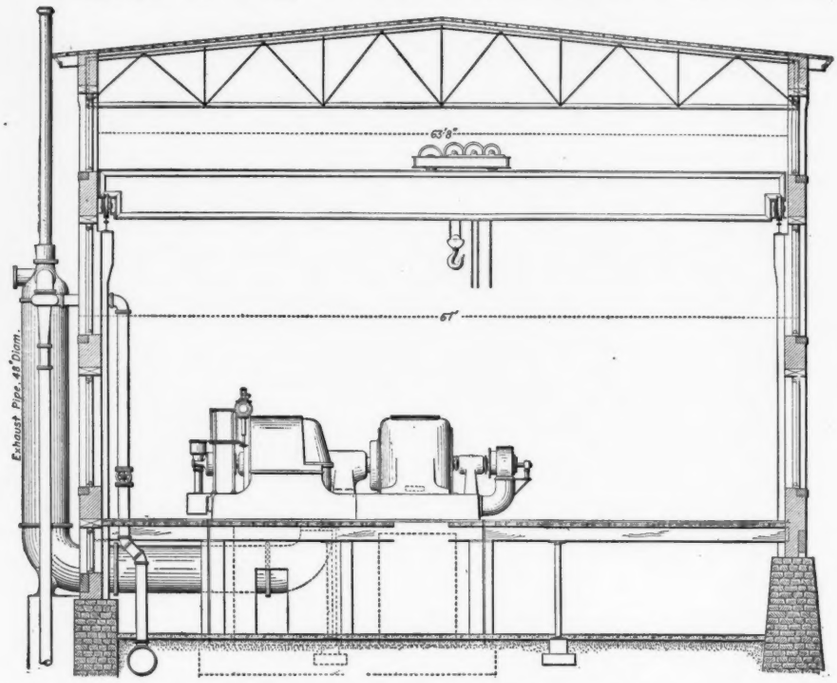
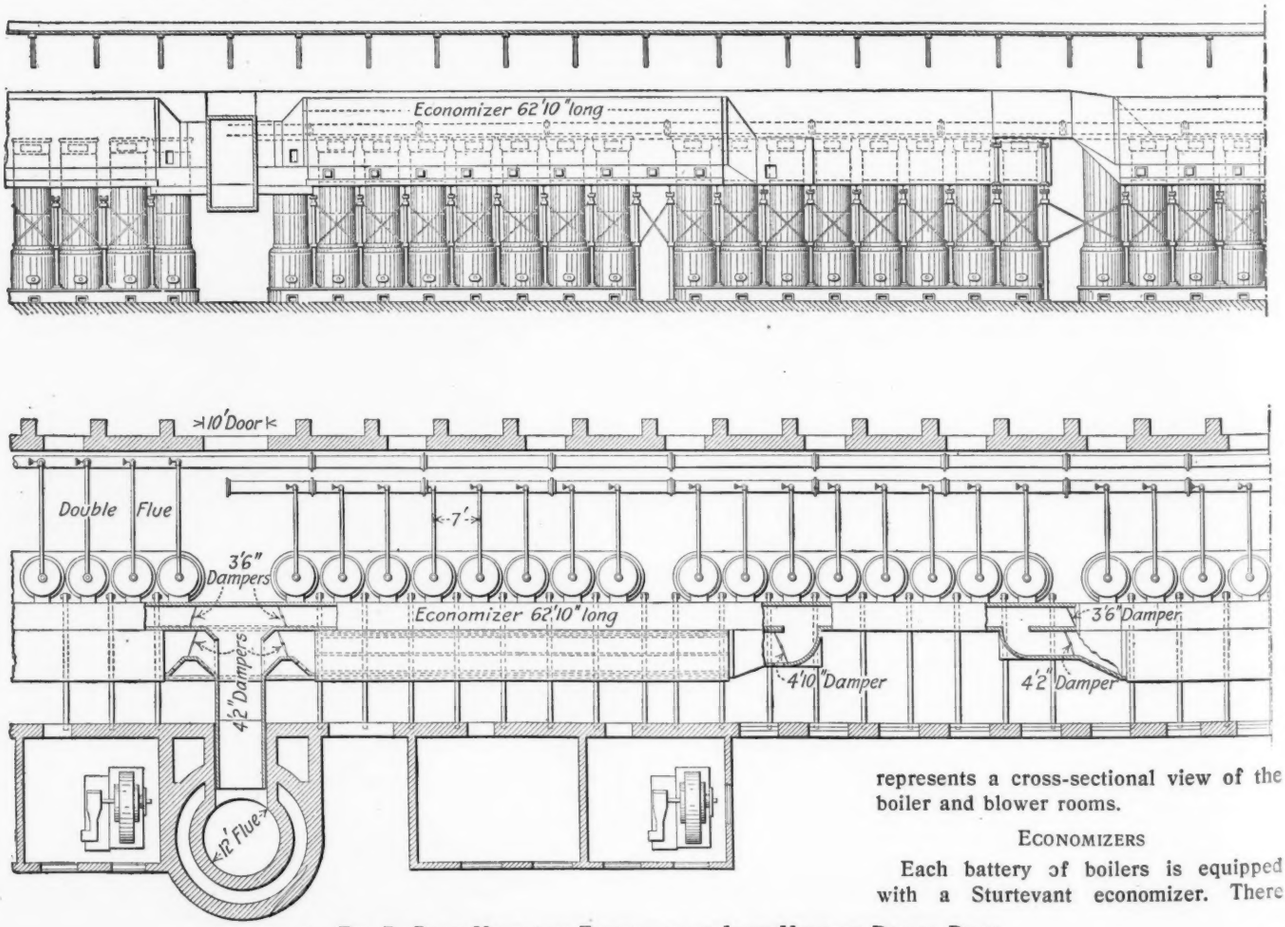


Fig. 6. Sectional Elevation of the Turbine Room

A Jones stoker is fitted to one side of each boiler furnace; the other side of the furnace is fitted with a cleaning door through which the fires are cleaned and kept in proper shape. One man handles six stokers, the work being that of keeping the hoppers filled with coal. One man cares for four fires on the cleaning side and one man wheels coal for eight boilers. When the entire boiler room is in operation, one man will be required per boiler, which includes the hopper man, the day and night boiler-room attendants and coal passers. A passage way has been left between each set of eight boilers, making it convenient for the men to pass from one side to the other without walking the length of sixteen boilers to do so. The boiler room has a concrete floor sloping toward the side wall so that after cleaning fires the fine ash and dirt can be washed to a trench next to the wall and out through a drain pipe into the river. Fig. 7 shows a plan and elevation of the boiler room. Fig. 5



represents a cross-sectional view of the boiler and blower rooms.

Economizers

Each battery of boilers is equipped with a Sturtevant economizer. There

Fig. 7. Plan View and Elevation of Left Half of Boiler Room.

are four in all and the scrapers are driven by one motor from a shaft attached to the side wall of the boiler room. These economizers can be cut out from the main smoke flue by means of suitable dampers, and the water passing through the tubes can be bypassed direct to the boilers, entering them at the temperature obtained in passing through the feed-water heater; this is about 130 degrees, and passing the water through the economizer raises its temperature 70 degrees.

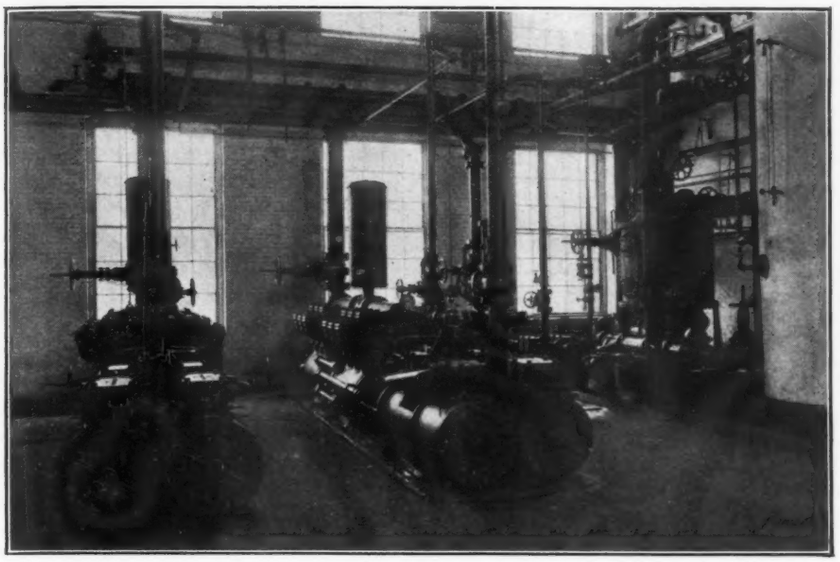


FIG. 8. PARTIAL VIEW OF THE PUMP ROOM

PUMP ROOM

In the pump room, which is located between the boiler and turbine rooms, and illustrated in Fig. 8, are two Worthington 14, 20 and 12 by 15-inch duplex boiler-feed pumps, pumping against a pressure equal to 190 pounds. There is also one 12 and 7½ by 10-inch duplex pump, which is used when but few boilers are under steam. The exhaust from these pumps and the blower engines go through a Reilly multicoil feed-water heater and then through an open heater. The feed water passes through the heaters in a direction opposite to the flow of the steam, so that the hottest water receives the heat from the hottest steam.

BOILER-ROOM PIPING

All overhead pipes throughout the boiler and the pump rooms are suspended from wall brackets by means of chains and hook bolts, as shown in Fig. 7. In some instances two pipes are suspended from the same bracket by means of an extension piece, as shown in Fig. 8. This method of pipe suspension is very flexible, as the hook bolt can be adjusted so that a pipe may have any desired pitch. It also allows the free movement of the pipe when under expansion or contraction stresses. The two main steam pipes expand 1 foot in their 500 feet of length. Both are anchored about 30 feet from the end next to the turbines and the expansion is all toward the other end. In order to overcome undue stresses in the pipes leading from the boilers to the main steam pipes, swivel joints are used on all of the boiler connections with the exception of the first nine boilers nearest to the pipe anchor. The swivel joints consist of a sleeve having a flange the size of the pipe connection at one end and a smaller flange at the other. Over this flange a two-piece gland is fitted, and this is followed by a collar. Square packing of suitable make is placed between the split gland and the ring washer which fits over the smaller gland on the sleeve. One section is secured by means of flange bolts to the outlet pipe of the boiler, the large flange of the sleeve is secured to the pipe leading to the main by means

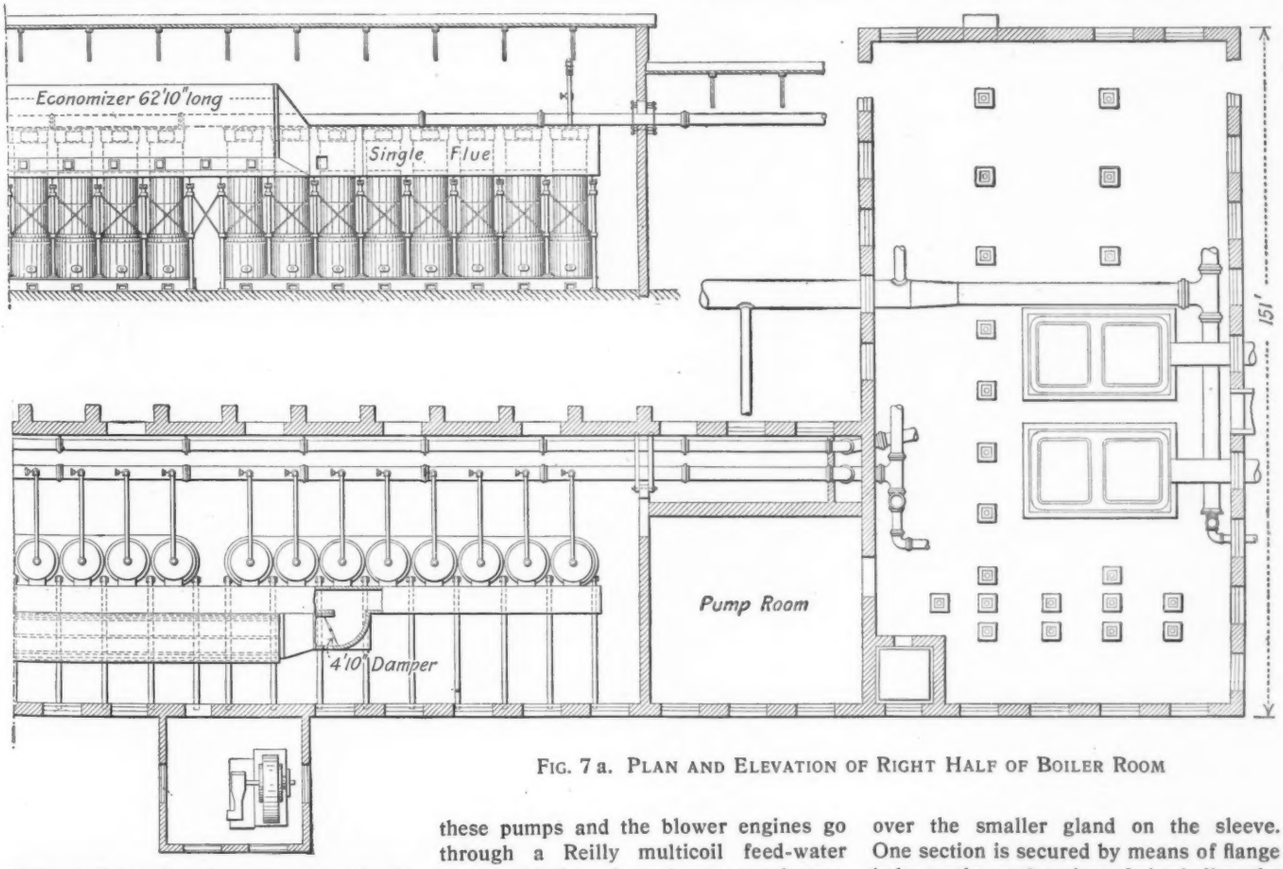


FIG. 7 a. PLAN AND ELEVATION OF RIGHT HALF OF BOILER ROOM

of bolts, while the two-piece gland and washer is secured to the upper gland. This allows the pipe and sleeve to turn in either direction. The first set of thirty-two boilers is connected to one steam main and the second set is connected to the other steam main. In order to permit steam to be used in either main in case of accident, the first eight of the second set of thirty-two boilers are connected to both steam mains, the upright pipes of each boiler being fitted with two of these expansion joints. This allows the top pipes to turn in one direction in case the main is cold, and the lower pipes to turn in the other direction when the other main is hot.

The feed pipes are divided into four sections, one for each battery of boilers, and are placed on brackets on the rear side of the boilers; the live steam and exhaust pipes from the stokers are also suspended from these same brackets. The live and exhaust steam pipes from the blower engines are suspended from brackets running along the outside wall of the boiler room. At a convenient point on the stoking side of the boilers, an iron walkway is provided for the water tender. Hand regulation of the feed water is maintained.

Handling the Coal

One idea in having the boiler room of such length was to make it convenient for handling the coal from the storage bins to the boilers. These storage bins have a capacity of 16,000 tons. The coal is brought to the plant by rail and is unloaded to the bins by means of a clam-shell bucket, which is operated from a traveling coal conveyer. This runs on a track, one rail of which is supported by concrete piers and the other rail by the brick piers, forming a part of the boiler-room wall. This bucket is capable of handling one ton of coal each lift and besides being used for the unloading from the cars to the coal pile it is also used to convey coal from the outside edge of the pile close to the boiler-room doors in case the coal supply becomes low. All the coal consumed in this plant is wheeled in coal cars, each having a capacity of 500 pounds. The ash is also handled in the same manner.

Stack

Midway of the building and on the outside, is a 200-foot brick stack which has a 12-foot flue. Owing to the forced draft, considerable fine coke and ash is carried to the base of the stack through the smoke flues, it being too heavy to go out at the top. It is necessary to remove this about three times a week, the total amount of accumulation being about 15 cubic yards per week. A rather unique idea has been worked out for removing this ash. An 8-inch pipe is built into the base of the chimney, extending level with the concave bottom. In this pipe a small ¾-inch air pipe is inserted with a U-bend on the inner end. When it is necessary to remove the accumulation of fine coke and ash, air is turned on this small pipe at a pressure of 100 pounds per square inch. The air passes to the U-bend, where its direction of travel is reversed, and as the air escapes from the end of the pipe, a partial vacuum is formed, which draws the accumulation to the base of the stack and discharges it through the outlet of the large pipe into the river. This eliminates the necessity of handling the fine ash deposits by means of manual labor.

This power plant was designed by and erected under the supervision of Capt. Charles H. Manning, mechanical engineer of the Amoskeag company, from which the foregoing data and accompanying illustrations were obtained.

Engine Room Mismanagement

By Hubert E. Collins

Several instances in which outside help had to be called in to solve difficulties which could have been overcome by the exercise of common sense on the part of the engineer.

In a certain hospital in New York City the operating conditions were very bad. Investigation showed that all high-pressure drips led through leaky traps into the sewer. About half these traps were not working at all and the steam was bypassed direct into the sewer. The cylinder and steam-chest drips on each of the engines were connected together and led to a leaky trap. One of these engines was operated continuously and the other two were operated during the winter from four to six hours each evening. The engineer in charge operated the engines with these drips wide open all the time. The steam from the steam chest leaked into the cylinder drips and alternately from end to end of the cylinder. The engineer claimed that it was necessary to operate with the drips open, as water sometimes came over from the boilers. It was true that the boilers were dirty and foamed at times, but he ran more chance of wrecking his engine by leaving all the drips open while running, connected as they were, than by closing them. Upon examination the boilers were found to be coated with scale from $\frac{1}{32}$ to ⅛ inch thick.

The exhausts from two feed pumps and one large house pump, in continuous operation, were piped to the atmosphere, and the hot-water supply was heated by live steam. The low-pressure drips were trapped and led with the returns from the house-heating system into an open heater, from which the water was drawn to feed the boilers. The fact that the hospital was free from water tax gave the engineer the impression that it did not matter how much water was used. But all water in the building was taken from the large house tanks on the roof, to which it was first pumped by the house pump. The low-pressure drips which entered the open heater with the heating returns were found to be bypassed by the traps and created enough pressure in the heater to cause all the water to siphon out into the sewer; consequently the cold water from the mains poured into the heater almost continuously, to supply the makeup to the boilers. This necessitated burning more coal in order to get up steam; but the worst feature of the arrangement was that the house pump had to be in continuous operation to keep the tanks full, and at times this pump could not supply all the water needed.

The passenger elevator was in bad condition, having poor contacts in the controlling box and on the magnets; the counterweight cables were too long and some contact springs were broken. Also, the freight elevator was shut down because many of the push buttons were out of order.

The fire service, which is so important in a hospital, was not in operation at all. The standpipes had no water in them, as the valves connecting them to the house tanks were closed. The hose had never been tested, the porters had never been drilled for fire service, and when the fire gongs were tried the wiring was so defective that they would not ring.

The engineer had been in charge of the plant for four years, having taken charge when it was new, and had not inquired into a single feature of operation tending toward its betterment. When anything broke down he was accustomed to send for outside help, and had allowed the plant to become a menace to the safety of the occupants of the building.

The board of directors finally called in outside aid, and when these defects were pointed out to the engineer he declared they could not be helped, and that he was operating as well as anyone could under the circumstances.

The first changes that were made were to stop all leaks past traps and to connect all pump exhausts to the heating coils in the hot-water tanks. This saved the use of live steam for heating water, and, by saving all of the drip returns from the heating system, it cut off entirely the use of cold water for boiler feed, while at the same time, the house pump was not required to operate more than one-third the time.

All these changes to effect economy and give uninterrupted service on the elevator and lighting service required about two months, but in the first month the coal bill was cut from $710 to $590 on the same output, and during the second month so much saving in steam consumption had been effected that only one boiler was required, whereas two had formerly been in constant service. This boiler steamed so easily after having been overhauled that a low grade of coal was used, with the result that the second month's bill was $280; at which figure it kept during all the winter months.

A Lack of Ordinary Judgment

An instance where the man in charge did not use ordinary judgment in locating a simple cause of trouble is shown in the following:

At a certain summer resort a hotel stands on piling out over the bay. The lighting is furnished by a small isolated plant located in a separate building, and the equipment consists of a locomotive boiler, a small high-speed engine and a dynamo. The engine has combined relief and drip valves, with a star wheel having a rising stem. When the stem extended through the wheel, the operator knew that the drips were open, and when the wheel was loose on the stem he could tell that they were closed.

The drips from the cylinder led through these valves and in this instance were piped together into a tee, as shown in Fig. 1. From the tee the drips led outside the building and discharged into the bay. The water supply to the hotel and the feed water for the boiler were taken from one tank.

The complaint was made that the engine ran badly, that the exhaust made so much noise as to annoy guests and cause them to leave; furthermore, that the engine used so much steam that it had to be shut down by 9 or 10 o'clock in the evening, leaving the place in darkness as the hotel was not piped for gas.

An expert was called in and discovered the cause of the trouble immediately upon entering the engine room. It all lay in the engineer's misconception of how the drip valves looked when open. When the expert looked at the engine he casually remarked that the drips were open, as was not unusual, for the engine was standing idle. The engineer said that they were all right, as he had set them that way when he first took the job and they had remained so all the time.

Questioning confirmed the fact that the engine had been running with the drips wide open all the time. The cylinder was 7 inches in diameter, with 1½-inch drips, which were wide open for steam to flow from end to end of the cylinder, the surplus exhausting in a steady roar

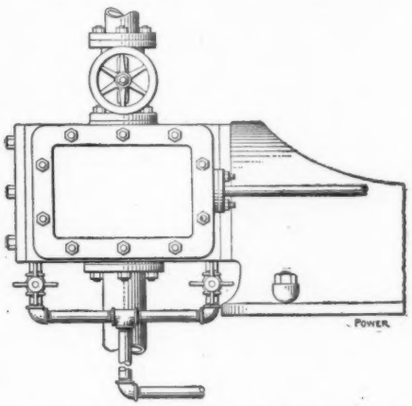


Fig. 1. Showing Drips Piped Together

out of the drip line. Here was the cause of all the trouble and the engineer did not understand enough about running an engine to know that steam should not come in a steady stream from the drip pipe from the cylinder.

was told that the engine not only would not govern, but used so much steam that the boiler could not keep up the required pressure to run longer than half an hour at a time. The engine had been shut down for two weeks' repairs and after being started behaved in this way. The cylinder and valves on this engine are illustrated in Fig. 2, which shows the steam and exhaust valve on the crank end, the head-end valves being cut away to show the steam passages.

The engine was started to observe its action and the first thing noticed was that steam was steadily blowing through somewhere. The trouble was located at once on the crank end of the cylinder. After shutting down, the steam-chest cover on the crank end was taken off, and while turning the engine one complete revolution, it was observed that the steam valve did not seat by ⅝ inch at any time. The steam was blowing through on that end all the time, but why this valve should not seat was puzzling, for the stems appeared, as shown in Fig. 3, with the lower end turned to a small shoulder. This small end enters the yoke up to this shoulder and is secured in place by a set screw, as can be seen in Fig. 2.

The valve stem in this instance was apparently down on this shoulder and the valve should have seated.

When the valve and stem were taken

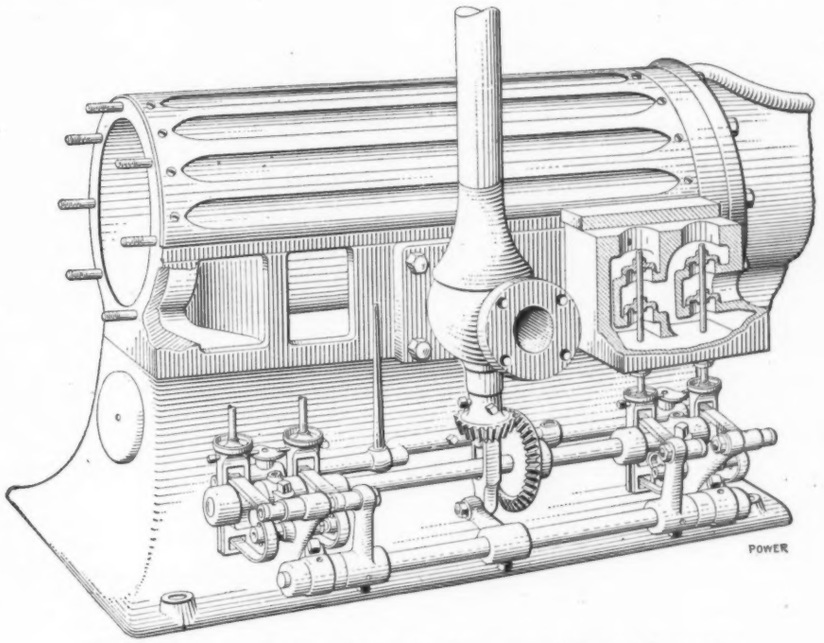


Fig. 2. View of Engine Showing Valves and Steam Passages

Trouble Could Have Been Prevented

Another instance where a little observation and thought would have prevented trouble is shown in the following incident: The engine in a factory plant was giving trouble and the engineer, acknowledging himself to be at a loss to account for the cause of the difficulty, allowed the proprietor to send for outside aid. When the expert arrived, he

out, the cause of the trouble was apparent. The valve stem had worn small in the stuffing box; at least, it had been turned off up to the first valve disk, the size of the small end of the stem, and a bushing had been put over the stem, making it the original size, with the lower end of the bushing forming the shoulder to bring up on the valve yoke. It was assumed that at some time the valve stem

had become loose in the yoke and slipped up through the bushing until it was flush with the end of the valve stem, so that whoever took it out thought the small end was broken off, not noting the gap on the stem between the bushing and disk.

At any rate, the bushing on the stem had slipped down to the end of the old stem and a hole had been drilled and tapped into this, with a stud screwed into it, making the whole stem length longer by as much as the bushing had slipped down, in this instance 5/8 inch. This is shown by Fig. 4, where *A* is the gap between the bushing and disk on the stem. The amount added to the length is apparent. The stem had been put back with this added length which did not allow the valve to seat.

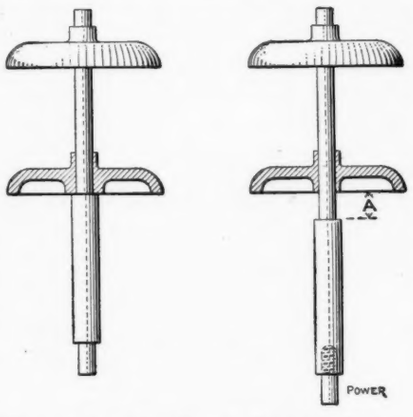
A striking feature of it all was that the valve stem was of steel and the bushing of brass; so that it attracted the expert's attention to the trouble at once. Neither the machinist nor the engineer had noted this, but had deliberately gone ahead and added to the length of stem and thus caused the trouble.

Pump Cylinders Out of Line

In a department store there is a large three-cylinder compound steam pump, the valves of which had been reset after a complete overhauling by an outside firm. The pump would have been accepted if the diagrams had not shown that with 120 pounds initial pressure in the high-pressure cylinder there was from 36 to 41 pounds back pressure in the high- and only 29 pounds initial pressure in the two low-pressure cylinders. This showed too much back pressure in the high-pressure cylinder and too great a loss in the receiver. The cutoff in the high-pressure cylinder was about 60 per cent. of the stroke, and this was changed to about 45 per cent. of the stroke, with the result that the receiver pressure was brought down to 30 or 31 pounds and the initial pressure in the two low-pressure cylinders remained at 29 pounds. This economized in the use of steam and by reducing the back pressure in the high-pressure cylinder, the same amount of mean effective pressure was obtained with less steam and the two low-presusre cylinders received enough steam to do their work. It proved that before the change was made there was too great a volume of steam admitted to the receiver for the low-pressure cylinders to take care of. After this slight change in valve setting, the work was accepted.

This pump has three steam and water cylinders, side by side, and the center line of the steam cylinder and guides is also the center line of the pump cylinder.

When the pump was first stripped for repairs, the repairmen were told to run lines through the cylinders and report if they were out of line. They reported to the chief engineer that the water ends were from $\frac{3}{16}$ to ½ inch low and would need raising. This would have necessitated the breaking of eight large joints on the water end, the use of tackle and jacks to raise the water cylinders and the resetting of the frames on the foundations, which meant an indefinite shutdown and the expenditure of several hundred dollars. They were ready to proceed with the work when the chief called on the outside man to go over the lines and verify the supposed conditions. This is what was found: In the first place, the lines of twisted cord, about 3/16 inch in diameter, had been put through the cylinders. These lines were too heavy for such work and one end was fastened outside the open end of the steam cylinder and, passing through the stuffing box, guides and water cylinder, was fastened outside the latter in such a manner that the line could not be stretched very taut.



Figs. 3 and 4. Valve Spindle Before and After Being Altered

Even with the most rigid attachment, this line could not have been stretched enough to prevent a serious sag. This attracted the attention of the investigator at once and, after observing the conditions, he took the calipers and proceeded to find the truth of the setting. He found the line set true in the steam-cylinder counterbore and in the stuffing box of the same cylinder, but along the guides and in the water cylinder the line was high, or the guide and water cylinder were low, getting worse toward the end of the latter. Each of the three water cylinders were low, according to the setting of these lines, but the investigator contended that there was a sag in the lines so that in order to set the line true at the steam-cylinder end the opposite end would have to be raised, and the water cylinders were low in varying degrees, according to the tautness of the individual lines.

He had these lines taken down and new, fine lines of woven sea grass substituted. Then they were stretched taut and set true at the steam end, after which it was found that all three of the guides and two water cylinders were in line with the steam cylinders, and one water cylinder was 1/16 inch low. This cylinder was lined up by shimming. The job took only two days, as against the weeks of work that it would have taken to make the other cylinders so much out of line that the pump could not have run, in the first place, and the work would have had to be gone over again before it was right.

High Gas Velocity in Boilers

Of late much attention has been directed to the increased heat-transmitting power of boiler plates by making the hot gases travel at a high velocity. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, has the following to say on the subject: High velocity means that the resistance in narrow and restricted passages is so much increased that it exceeds the resistance in the bed of fuel, and has to be seriously taken into account, and the question arises whether the extra cost for producing this necessarily powerful draft is balanced by the advantage of being able to use a small boiler. The question is perhaps deserving of attention by marine engineers, but with them the tendency is at present toward water-tube boilers, which, as is well known, offer very little resistance to the flow of gases. In any case trouble is almost certain to arise if the principle is carried to excess, for the effects associated with what may reasonably be called a blowpipe flame acting on a very small surface is that this surface tends to warp itself on account of very great differences of temperature on either side. If the water is sedimentary all the scale will be deposited locally and result in overheating, and in addition there will be difficulty in providing locally the necessary supply of water, without which, of course, no evaporation takes place, and overheating and bulging result. The locomotive boiler, the Lancashire multitubular and, in fact, most smoke-tube boilers, do cause the gases to move quickly, but further reductions of the tube section can only be made if artificial draft is resorted to, and artificial draft, although it is likely to be efficient in ordinary cases, where the natural draft is inefficient, does sometimes aggravate the evils which it is called in to remedy. The Admiralty had no end of trouble with leakages of the tube plates of its Scotch boilers because of the intense heat transmission at these parts.

Artificial draft has to be paid for in steam consumption, and when certain limits are reached no further gain is possible. In a recent case it was found that in spite of using 25 per cent. of the steam generated for jets, they added less than 20 per cent. to the steaming power of the boiler, which was therefore being more heavily worked than before, and yet supplying less steam.

Automatic Shaking Grates

By A. R. Maujer

Boiler grates originally designed to be shaken by hand were fitted with automatic shaking mechanism which resulted in improved operating conditions and economy.

With hand-fired furnaces and shaking grates a very common trouble is that the fires receive first a feast and then a famine of shaking, so to speak. Even though the fireman has had plenty of experience, he will neglect to shake the grates as long as he dares, in order to avoid as much work as possible and because it is slightly easier, probably, to operate the fires. As a consequence, the fires get dirty, the draft poor and the combustion becomes proportionately bad. When the grates finally are shaken, the fires are so broken up and the fuel bed so thinned that the temperature drops abnormally when green fuel is added.

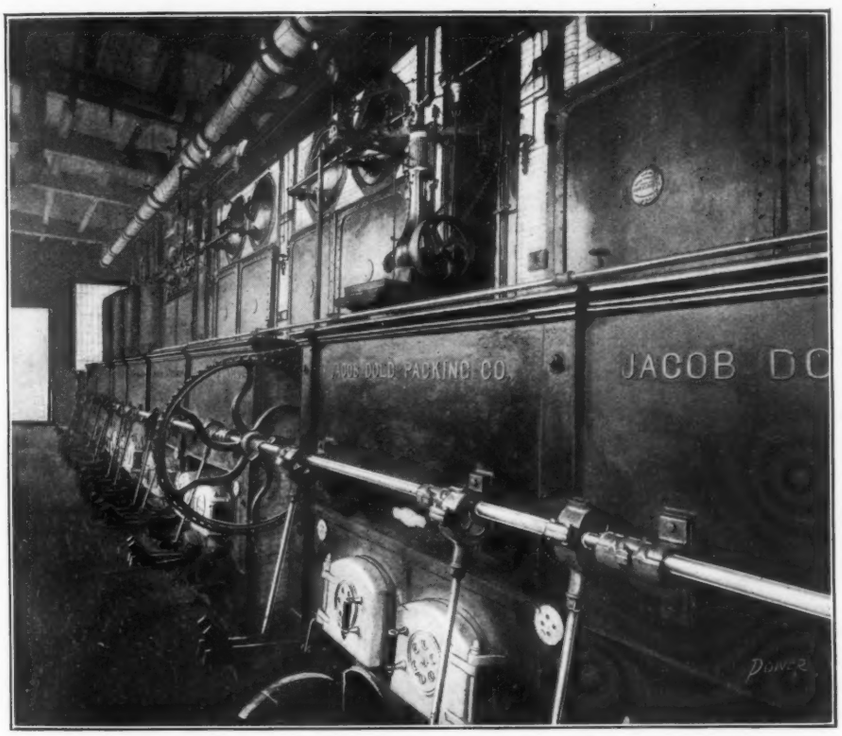


FIG. 1. MECHANISM FOR AUTOMATICALLY SHAKING THE GRATES

To eliminate this variable element in the operation of the fires, George Schautz, consulting engineer for the Jacob Dold Packing Company, at Buffalo, N. Y., has designed and installed in the Buffalo plant of this company an automatic shaking mechanism, using the same grates that were installed with the boilers.

As happens in the power plant of practically every growing industrial concern, a time came when the boilers as well as the engines and other apparatus were so heavily overloaded that extension became imperatively necessary. The original boiler equipment consisted of ten return-tube boilers, each rated at 100 horsepower. The boiler room was so located between other buildings that no additional floor area was available unless some other location was selected and an entirely new boiler house erected.

The original amount of head room in the boiler house was only 21 feet. By increasing this to 34 feet it was possible to install water-tube boilers in the place of the old fire-tube boilers and, without increasing the floor space occupied, secure a great increase in boiler capacity.

The first change to be made was the removal of five of the 100-horsepower fire-tube boilers and the installation in their stead of four Fitzgibbons boilers, each of 275 horsepower capacity. Later, the five remaining fire-tube boilers were replaced by four Keeler water-tube boilers of a combined rated capacity of 2140 horsepower. Both the Fitzgibbons and the Keeler boilers were fitted with Ajax shaking grates for burning run-of-mine bituminous coal which comes from the Shawmut, Penn., district.

After the new installation had been in operation for a few months, Mr. Schautz decided that conditions in the boiler room could be improved if some means were found to obviate the irregularity which the shaking of the grates by hand produced. After some study and considerable experimenting, the arrangement shown in the accompanying figures for automatically shaking the grates was installed in connection with the Keeler boilers. Later, it was extended to operate the grates under the Fitzgibbons boilers also.

The chief difficulty was to secure a low enough rate of rotation for the eccentric shaft. This was finally overcome in the manner shown. A small high-speed engine was mounted in the alley between two batteries of boilers. A small sprocket on the engine shaft drives a lay shaft by means of a chain and large sprocket on the latter. A small sprocket on the

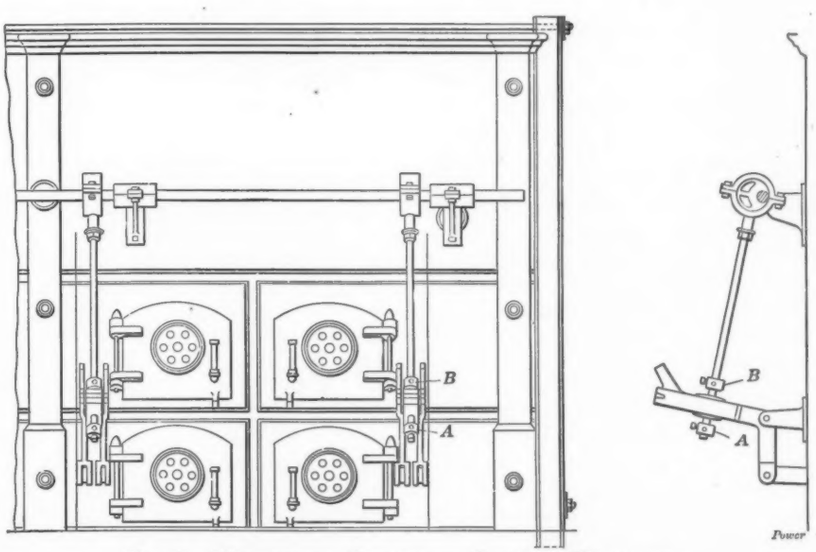


FIG. 2. MECHANICAL DETAILS OF SHAKING MECHANISM

lay shaft drives the chain which runs over the large wheel keyed to the eccentric shaft. In this manner the speed of the eccentric shaft is reduced to about two revolutions per minute.

The system has the greatest flexibility. Fig. 2 serves to illustrate the manner in which this flexibility is secured. The tappets *A* and *B* can be adjusted so as to give the grate either slight or considerable motion as may be desired; or, the eccentric rod may be completely disconnected when it is desired to shake the grates by hand or so allow them to remain entirely undisturbed for a period of time.

This automatic shaking arrangement has given complete satisfaction. It makes the firemen's work easier; the fires are maintained in a more even condition, and an appreciable gain in economy has been effected. The fires are carried at a uniform thickness of about 6 inches. The quantity of smoke emitted from the stack has been greatly reduced.

Recent Steam Engine Failures

By H. S. Knowlton

The description of a number of accidents taken from the reports of an insurance company, and the deductions arrived at by their investigators.

The following is an account of a number of recent accidents to steam engines, the facts being drawn from the investigations and reports of a large accident-insurance company:

The first case noted was that of a horizontal noncondensing engine fitted with a single slide valve driven by an eccentric keyed upon the crank shaft. The engine operated wood-working machinery, and was left without attention, as a rule, from the time the plant started in the morning until it was shut down at night. While the engine was in service it stopped suddenly, and it was found that the wooden wedge between the front end of the crank pedestal and the lug on the bedplate had come out of place and left the pedestal free except for the restraint of the holding-down bolts. The holes for the latter were long enough to allow considerable movement and the pedestal was forced forward sufficiently to bring one of the nuts which secured the slide valve upon its spindle into collision with the front end of the valve chest. The shock broke the eccentric strap, and at the same time the connection between the eccentric rod and the crank shaft thus leaving the slide valve stationary.

Another accident was caused by a stray bolt and nut. The trouble occurred in connection with a vertical, single-acting air pump, driven by links from the low-pressure piston-rod crosshead. The bucket was hollow, flat on top and conical on the under side, being divided internally by six radial ribs into compartments to which access was obtained by holes in the upper surface of the bucket; these had been filled by screwed plugs after the cores had been removed. The bottom of the pump was also conical, with a central hole 16 inches in diameter to facilitate boring. This hole was closed by a flanged and spigoted cover ⅞ inch thick, whose upper surface was turned to form the apex of the conical surface of the air-pump bottom. The cover was secured by fourteen ¾-inch studs.

While in regular operation one morning, the cover was broken and driven off. Upon examination a crushed and battered T-head bolt was found below the pump, and on drawing the bucket the nut belonging to the same bolt was found jammed tightly into a hole in one of the compartments. It appeared that the bolt, possibly with the nut screwed upon it, had become lodged in the bucket after the cores had been removed, and had been left there when the core holes were plugged. Here it had rolled about till the nut had come off, and the bolt or nut, or both, had worn a hole in the bottom of the bucket. The bolt, having a head smaller than the nut, had dropped through the hole, rolled to the bottom of the pump, and been driven through the cover by the next downward stroke of the bucket.

The next case was that of a 42x60-inch vertical condensing engine, running compounded with a 19x60-inch horizontal noncondensing engine, the two being coupled to the same shaft. The speed was 42 revolutions per minute and a boiler pressure of 110 pounds per square inch was carried. Each cylinder had a short slide valve, the valve chest of the horizontal engine being on the top of the cylinder and that of the other engine being on the side facing the crank shaft. The valves of the latter were driven by an eccentric keyed to the crank shaft through a light eccentric rod, rocker shaft and links below the engine-room floor. The cylinder was a plain tube, with a port at each end, to which the valve chest was bolted. Its cover and bottom were spigoted, so that the vertical distance between them measured on the inside was less than the distance between the extreme edges of the ports; therefore, water could not lie on the bottom of the cylinder without running into the port. The valve chest was a large rectangular casting with flanged openings half way up the right and left sides, to which the steam pipe from the horizontal cylinder and the exhaust pipe to the condenser were bolted. These openings were about 16 feet above the water surface of the pond from which the condenser was supplied. The air pump, driven in the usual manner, was 25 inches in diameter by 30 inches stroke. The condensing water was supplied through about 40 feet of 5-inch pipe, and there were two injection cocks, one 3 inches in diameter and the other 4 inches.

During the temporary absence of the engineer the fireman noted a change in the speed of the engines. He found the engine room full of steam, but was able to reach and close the stop valve of the horizontal engine. He then found the piston rod of the vertical engine disconnected from the crosshead, and the cylinder fractured nearly all around, close to the bottom flange. Further examination showed that the piston-rod cotter, which was 3½x¾ inches, had been sheared through, the crank forced about 1½ inches around the shaft, the rocker shaft which worked the valves being twisted and the cylinder bottom and piston broken. As no mark could be found on the piston or cylinder cover it was evident that the damage to the piston-rod cotter and the cylinder and the shearing of the keyway on the crank shaft had been caused by water in the top end of the cylinder, and that it had happened just before the crank reached the bottom center and the piston the end of its up stroke. It was also clear that the cylinder bottom had been fractured by the impact of the piston, driven down upon it by the steam pressure, when liberated from the crosshead. At first it was not evident where the water had come from, why there was no dangerous accumulation in the bottom of the cylinder, or how the twisting of the rocker shaft was related to the other damage. The following conclusions were arrived at by the insurance company's engineer:

First, a comparison of the volume of water supplied to the condenser per stroke, calculated from the temperatures of the injection and discharge, with the displacement of the air-pump bucket, proved that the water could not have come from the condenser. At the normal speed the displacement of the bucket was five and three-tenths times the volume of the water and condensed steam entering the condenser; consequently, the air pump would clear the condenser as

long as the speed of the engines exceeded $\frac{42}{5.3}$ or 7.9 revolutions per minute. The fireman who stopped the engines was certain that the speed was not as low as this. Therefore, the water came from either the pipe connecting the two cylinders, or from the boilers. The pipe was bolted to a nozzle on the left side of the valve chest of the high-pressure cylinder, and carried horizontally for a length of 10 feet toward the vertical engine, and then upward for 4 feet, entering the right side of the valve chest of the latter. It appeared that the water came from the boiler. The fireman had run the water nearly up to a full column, preparatory to shutting down for the night, and the boiler had begun to prime. The water carried over had passed through the high-pressure cylinder without accumulating enough to cause damage, and had been carried on to the valve chest of the other engine, where the lime and scum carried over interfered with the lubrication, causing the valves to stick and the rocker shaft to twist. The effect of this was to lower the valves about $\frac{5}{8}$ inch, and to put nearly this amount of lap on the exhaust edge of the top valve, while giving the exhaust edge of the bottom valve about the same amount of lead. The port at the bottom end of the cylinder then remained open for exhaust almost to the end of the down stroke, but that at the top was closed while the piston was yet some 9 inches from the top of the cylinder. Thus, small quantities of water entering the bottom of the cylinder could run back into the port and be blown into the condenser during the down stroke, but entering the top could not escape, owing to the port being closed before the piston reached its level. The water entering the top port, therefore, remained upon the piston and accumulated until its volume became greater than the clearance; then the break occurred. When the low-pressure valve chest was opened it was found that the valves and faces were covered with a white deposit, which proved that there had been priming, and the rocker shaft had also been twisted once before and at about the same time of day, apparently from the same cause. There was no relief valve on the top end of the cylinder of the vertical engine.

Another breakdown was caused by water entering the upper end of the low-pressure cylinder of a 10 and 14½ by 6-inch vertical engine. The exhaust pipe led from the valve chest of the low-pressure cylinder in a horizontal direction, then turned vertically upward for 2 feet, then ran horizontally for 7 feet and finally downward to the top of the condenser, a conical receptacle of small capacity. The higher of the two horizontal lengths of the exhaust pipe was about 10 feet above the surface of the pond from which the injection supply was drawn. The air pump was of the horizontal type, with a 12x10-inch cylinder, and was steam driven. The frame which inclosed the cylinder and the moving parts fractured circumferentially close to the flange by which it was bolted to the bedplate. It appeared probable that the accident had been caused by the air pump failing to discharge the water forced into the condenser by the atmospheric pressure on the surface of the pond. This might have occurred in two ways: first, owing to the steam pressure being reduced previous to stopping, the air pump might have been running at a speed just sufficient to keep the condenser clear while the normal supply of water was passing through the injection cock, but not sufficient to discharge the larger supply which would enter the condenser when the vacuum improved owing to the governor's cutting down the steam supply when the machinery was being shut down; second, the engineer may have slowed down or stopped the air pump before destroying the vacuum in the cylinder. The condenser was equipped with a float designed to operate a small atmospheric valve in the event of the water rising above the normal level, but as the engineer had never seen the inside of this mechanism it was probably out of order; or, if it did lift the valve, the air entering was unable to destroy the vacuum before the water reached the cylinder. The insurance company's engineer called attention to the fact that water entering a condenser under a vacuum of 12 pounds had a theoretical velocity of about 42.5 feet per second, and an actual velocity of about 25 feet per second, which is sufficient to carry a considerable quantity of water into the condenser, even after the vacuum has been destroyed if the injection pipe is long. The best practice is to stop the engine before shutting down the air pump, in independent condensing plants.

A case of piston-rod breakage occurred in a triple-expansion engine running at 62 revolutions per minute, where the high- and low-pressure pistons were carried tandem on one rod, and the intermediate piston on the other. The rod carrying the two pistons was 16 feet long by $3\frac{11}{16}$ inches in diameter where it entered the crosshead, to which it was secured by a $3\frac{1}{4}$x$\frac{7}{8}$-inch cotter, with rounded edges and a taper of $\frac{1}{16}$ inch per inch. The cotter hole in the rod was 1⅛ inches broad and $4\frac{7}{8}$ inches long, and the inside diameter of the socket in the crosshead to which the rod was cottered was $\frac{1}{16}$ inch larger than the diameter of the rod. Two steel disks, or shims, each ⅛ inch thick, were inserted between the end of the rod and the bottom of the socket, probably to compensate for reductions in the effective length of the connecting rod by the wearing of the brasses.

The piston rod gave way inside the crosshead socket at the cotter hole. The two pistons which it carried were projected backward, driving out both cylinder covers, cracking the larger cylinder back of the flange and breaking some of the studs connecting the front end of the high-pressure cylinder to the engine bedplate. From the appearance of the rod it was evident that the failure had been gradual. It appeared probable that if the rod end had been carefully examined when it was taken out of the crosshead to put in a new packing piece, the crack would have been discovered and the failure averted. The cause of the initial fracture could not be determined, but there was little doubt that it was concentration of stress upon a small part of the cross-section of the rod by the pressure of an imperfectly fitting cotter. The load upon the pistons, divided by the cross-sectional area of the rod, was 6700 pounds per square inch.

Neglect of proper foundations in erecting new engines upon an old site led to the breaking of a bedplate in connection with a 1700-horsepower horizontal tandem-compound engine. The foundations for the original engines had been built of good ashlar blocks, but during many years of service the stones became saturated with oil, the cement softened and squeezed out of the joints, and settling took place, especially under the crank-shaft bearings, until finally the bedplate broke. When the replacement of the engines was under consideration the casualty company's engineers advised the rebuilding and strengthening of the foundations, but on account of a lack of time this advice was disregarded, and the new engines were erected upon the old dilapidated seats. As soon as they were put in operation, movements were observed, and, although the joints between the stones were wedged open, cleared out and pointed, and the engine bedplates wedged up and screwed down, neither the engines nor their foundations could be made firm. A week was spent in clearing out oil from the joints of the stones and the bottom of the foundations; the joints were again run with cement and the movement was much reduced, but the flywheel and shaft were not lifted to take their weight off the bearing, neither were the nuts of the holding-down bolts slackened, to allow the bedplate to come to its natural positions so that it might be packed and properly supported. The result was that the bedplate cracked near the holding-down bolt next to the crank-shaft bearing. This accident illustrated the great importance of keeping oil off the foundations, particularly in cases where engines are erected on concrete foundation structures.

In this connection the insurance company's report pointed out that when using concrete foundations, bedplates cannot be planed on their under sides and bedded by rubbing against the foundation. They

are usually leveled up on small iron wedges and grouted with cement or fine concrete. The bearing surfaces on the under sides are often not more than 3½ or 4 inches wide, and even when kept dry are insufficient to hold a heavy engine absolutely steady for any length of time. As soon as motion begins, the cement is ground away and the wedges become loose. To stop the motion the foundation bolts are tightened, and so the process goes on till the bedplate breaks. When oil reaches the grouting, destruction is far more rapid. It is good practice, if wedges are to be used, to have them machined and of substantial thickness and large area, bedded to machined surfaces on the under side of the bedplate at each foundation bolt. The lower wedges should be set at the right level in cement, and the upper lightly driven between them and the bedplate, when the latter is in position, on temporary supports. At the crank end, projections may be cast on the under side of the bedplate to engage in recesses in the concrete, to prevent end motion. If wedges are not relied upon, the bearing surfaces on the under side of the bedplate must be broad, so that if the oil softens the edges of the grouting there may still be sufficient hard cement between. Footings at least 8 or 9 inches wide are desirable with large engines. The foundation bolts should also be increased in number to make the bedplate grip the grouting at as many points as possible. The most substantial plan, however, is to cover the concrete where the engine is to rest upon it with strong cast-iron plates with raised facings to receive the planed feet of the engine bed and raised edges to return oil and water.

Corrosion and the accumulation of scaly deposit in a 100-kilowatt steam turbine caused serious damage to the machine only five months after a complete overhauling. The turbine had fifty-four rows of blades, increasing in diameter from 6½ to 12½ inches, and its speed was 3000 revolutions per minute with a boiler pressure of 160 pounds per square inch. All the blades of the first thirteen rows at the high-pressure end and the corresponding blades in the casing were broken off at the roots and crushed into one mass, which stopped the turbine. In addition half the blades in the next eleven rows were found to have been in contact with the casing, but it was not possible to determine whether this had happened before or after the first thirteen rows had been stripped. The blades of the high-pressure end were of copper, brass being used at the low-pressure end.

Can and Plate Systems of Making Ice

By F. E. Matthews

What is meant by "can ice" and by "plate ice" and a description of the processes involved in their manufacture. The economic phase of ice making is also touched upon.

Next in importance to the direct utilization of refrigeration, such as for the cooling of perishable products, etc., is that of artifical ice making. While there are a number of systems which may in the future modify present methods, practically all the ice produced today is made by either the can or the plate system.

The Can System

In general, the process of manufacturing can ice consists of immersing cans of water in brine tanks not unlike those employed for cooling brine for brine-circulating systems. First, the specific heat, then the latent heat of the water is given up to the brine which, in turn, passes it on to the liquid refrigerant, most commonly ammonia.

Distilling Apparatus

Since any impurities in solution or suspension in the water fed to the cans are eventually frozen into the ice, it becomes necessary to use water as nearly pure as possible. The purity of ice, however, is somewhat erroneously judged by its transparency. Impure ice may be almost entirely transparent while, on the other hand, pure ice, except for the presence of air which produces whiteness, may be unsalable because of its opaque appearance. To remove air as well as both organic and inorganic impurities from the water, distilling systems are usually employed in can ice-making plants. As large quantities of water must be evaporated to make the steam necessary for driving the ammonia compressors and other machinery of an ice-making plant, it follows that the boilers and engine should constitute a part of the water-distilling system.

Fig. 1 illustrates diagrammatically the simple or high-pressure system commonly employed in making can ice. As a steam boiler is virtually a thermal filter which separates out, in the form of incrustation and sludge, most of the impurities brought to it in the feed water, the water supply for an ice plant should be selected with particular care, especially as it often becomes necessary to supply raw "make-up" water to the storage tank when the supply of distilled water runs short.

As shown in the illustration, the exhaust steam from the engine driving the compressor passes first to the grease separator in which it is freed of a large part of the entrained lubricating oil by impinging upon baffle plates. From the grease separator it passes to the steam condenser from whence, after being condensed, it flows to the reboiler, skimmer and hot-water storage tank. From the latter the hot distilled water is allowed to flow as required into the water cooler; entering at the bottom and passing up through a series of pipes it is here cooled by water flowing down over the outside of the pipes. From the water cooler it passes to a charcoal filter or deodorizer and on through a hose to the can filler. When frozen the ice is removed from the cans by spraying with hot water and then gravitates down an incline into the ice-storage room.

In traversing that part of the system between the steam condenser and the ice cans the distilled water, after having been freed from air and other gases in the reboiler, is not again allowed to come in contact with the air; the reason for this is twofold: First, any air entering into solution in the distilled water will separate out in the form of minute bubbles during the freezing process and give the ice an opaque appearance; second, distilled water in the presence of air is very corrosive to iron and should they be allowed to come in contact with any part of the system not thoroughly protected by galvanizing, a sufficient amount of iron would be dissolved to discolor the ice.

Freezing Time Required for Can Ice

With brine at 14 degrees the average time of freezing different-sized blocks of can ice is as shown in the following table:

TIME REQUIRED FOR FREEZING CAN ICE.

Size of Can, Inches.	Weight of Ice, Pounds.	Freezing Time, Hours.
6x12x26	50	15—25
8x16x32	100	30—50
8x16x42	150	30—50
11x22x32	200	50—72
11x22x44	300	50—72
11x22x57	400	50—72

While no exact rule can be formulated for expressing the freezing time in terms of difference in temperature between the brine and the freezing water in the can, because of the fact that the heat-transmitting surface of the freezing water is decreasing and the insulating effect of the ice forming is increasing; it, nevertheless, has been claimed by some that the time required for freezing can ice

with brine at the usual temperature varies directly as the square of the thickness of the cake of ice. On this basis the relative time of freezing 6-inch and 11-inch blocks would be as 36 is to 121, or allowing 50 hours for the latter, the former should freeze in 14.9 hours.

The Plate Ice System

Where pure water is available the can system with its distilling apparatus is often replaced by the plate-ice system. The important requisite of any ice-making system from a commercial standpoint is its ability to produce marketable ice, which, unfortunately, often depends more upon the appearance than upon the purity of the product. In the can system practically all solid impurities are left behind in the process of distillation, air and foreign gases being expelled by violent boiling in the reboiler. In the plate system the keeping of the product free from both solid and gaseous impurities is almost wholly dependent upon the agitation of the freezing water. Snow may be pure but it is white because of the presence of a large number of minute air spaces between the crystals of ice. Gases, in general, are soluble in liquids, the degree of solubility varying widely with the temperature and pressure; the higher the pressure and the lower the temperature, the greater the amount of gas a liquid will absorb. In the case of freezing water, however, the air is driven out of solution and collects in the form of little bubbles on the freezing surface. These bubbles will finally be frozen into the ice if not forcibly dislodged.

In the manufacture of plate ice the principal inorganic impurities to be guarded against are the salts of iron which give a reddish discoloration, and the carbonates and sulphates of lime and magnesia which produce a slight cloudiness. Unless large quantities of magnesium carbonate or carbonate of iron are present the effects of these impurities, as well as that of air, can be overcome by increased agitation. In the case of carbonates of either magnesia or iron, increased air agitation may tend to increase the discoloration through the hydrating of the former and the oxidizing of the latter. This difficulty may be overcome, however, by the substitution of mechanical for air agitation.

Mechanically, a plate plant is so constructed that the raw undistilled water to be frozen is brought in contact with plates of sheet metal bolted to either brine or direct expansion coils in which a sufficiently low temperature is maintained to bring about the necessary heat transfer from the water at 32 degrees. These plates, which are not usually less than 14 feet long by 10 feet deep, are submerged in the plate tanks. The refrigerating agent, whether brine or ammonia, is allowed to flow through the coils until ice has accumulated to a thickness of 12 to 14 inches on the plate. The cold brine or ammonia is then shut off and hot brine or ammonia is circulated through the coils until the ice is loosened from the plate and floats free in the water. Chains are then fished around the cake and it is hoisted from the tank by a traveling crane and carried to a tilting table where it is carefully deposited to avoid breaking. Here it is sawed into cakes of the required size, by two gages of traveling circular saws, one traveling lengthwise and the other crosswise of the table. Because of being frozen from water at 32 degrees Fahrenheit with which it is always in contact, the actual temperature of plate ice is not as low as that of can ice, the temperature of which is limited only by the temperature of the brine. On account of this fact, plate ice is less likely to be brittle, has less tendency to freeze together and, therefore, can be stored more readily than can ice.

The factor which limits the application of the plate system is the time required for freezing, the absorption of heat having to take place in this case wholly from one side while that in a can is from five sides. This disadvantage has been overcome to some extent in the "Center-freeze" system in which the plate of ice is frozen on a comb-formed series of vertical brine pipes attached at the top to suitable feed and return headers. In this system heat is absorbed radially from all directions by each pipe and, being located in the center of the plate of ice, the total thickness of ice frozen through need never be over half that of the usual plate system producing a plate of the same thickness. The center pipes are loosened from the ice as in the preceding case.

Evaporators and Vacuum Distilling Apparatus

In can ice-making plants of over ten tons daily capacity and employing engines of the Corliss type, there is seldom sufficient sweet or distilled water from the exhaust-steam condensers to supply the freezing tanks. This debars maximum steam economy where the usual high-pressure distilling apparatus is employed. For instance, assuming a 100-ton ice plant requiring 2.75 horsepower per ton and operated by a four-valve engine using 30 pounds of steam per horsepower per hour, the steam required for the engine would be about 100 tons per 24 hours. The auxiliaries and reboiler, together with the usual condensation and leakage past the valves of the engine and auxiliaries would probably amount to 25 tons, making in all about 125 tons of steam. This amount of steam would supply sweet water for the 100-ton can plant and allow for a loss of 20 per cent. between the exhaust pipe and ice cans. If, however, the loss were as much as 24 per cent., which might readily happen, the make-up water required would amount to about 8000 pounds per 24 hours. This quantity of steam at a cost of 20 cents per thousand pounds would be worth $1.60 per day.

If the engine employed were of the Corliss type, simple noncondensing and having a steam consumption of 28 pounds per horsepower-hour, the steam required to drive the compressor would be about 92.4 tons. Hence, the amount of make-up water, even on the basis of 20 per cent. waste, would be 52,160 pounds, which at 20 cents per thousand pounds would cost $10.43 per day.

From the foregoing it is obvious that

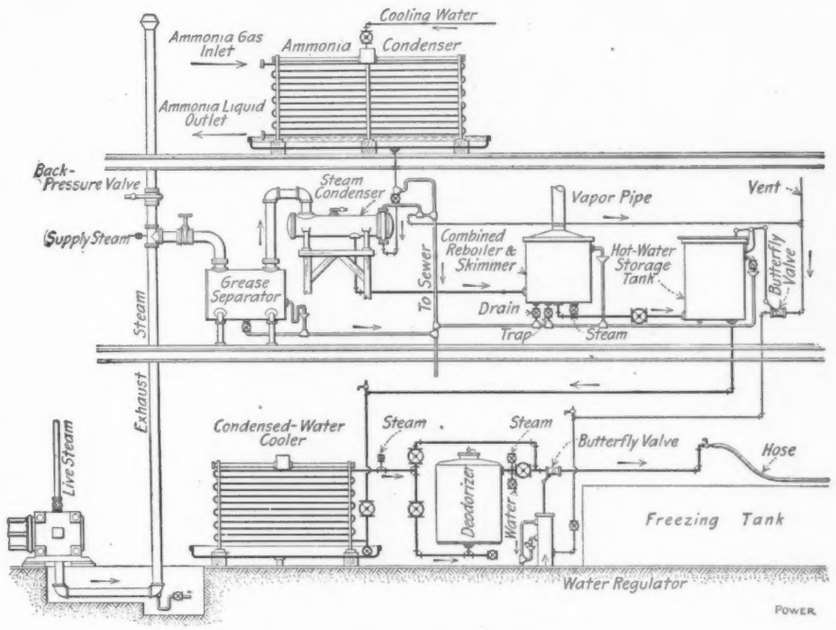


Fig. 1. System for Making Can Ice

to employ engines of lower steam consumption results in developing an ice-making capacity in excess of the amount of sweet water available. This excess capacity over that required to freeze the available distilled water, may be employed to freeze ice in a plate tank, or the deficit in sweet water necessary to supply the can plant may be made up by means of evaporators.

A combination can and plate plant, designed to satisfy the first of these conditions is illustrated diagrammatically in Fig. 2. Leaving the ammonia compressor the gas is first discharged into the two pressure tanks where any entrained oil is deposited. From there it passes through pipe *B* to the condensers and after liquefying it flows through pipe *D* to the liquid receiver. The line from the bottom of the liquid receiver branches off, line *F* supplying the can plant and ice-storage room and *E* supplying the plate plant. The water forecooler is fed in series with the plate plant, after passing through which, the ammonia gas returns to the compressor.

The circuit traversed by the sweet water is as follows: The exhaust from the engine, encountering the back-pressure valve on the main exhaust pipe from the engine, is diverted through a grease separator into a steam condenser. The condensed water then passes through the ice cans as required. The water for the plate plant passes first through the water filter in the engine room, through the water forecooler and into the plate tank. Similarly the air used for agitation in the plate-ice tank is discharged by the air compressor through an air-storage tank in the engine room, through

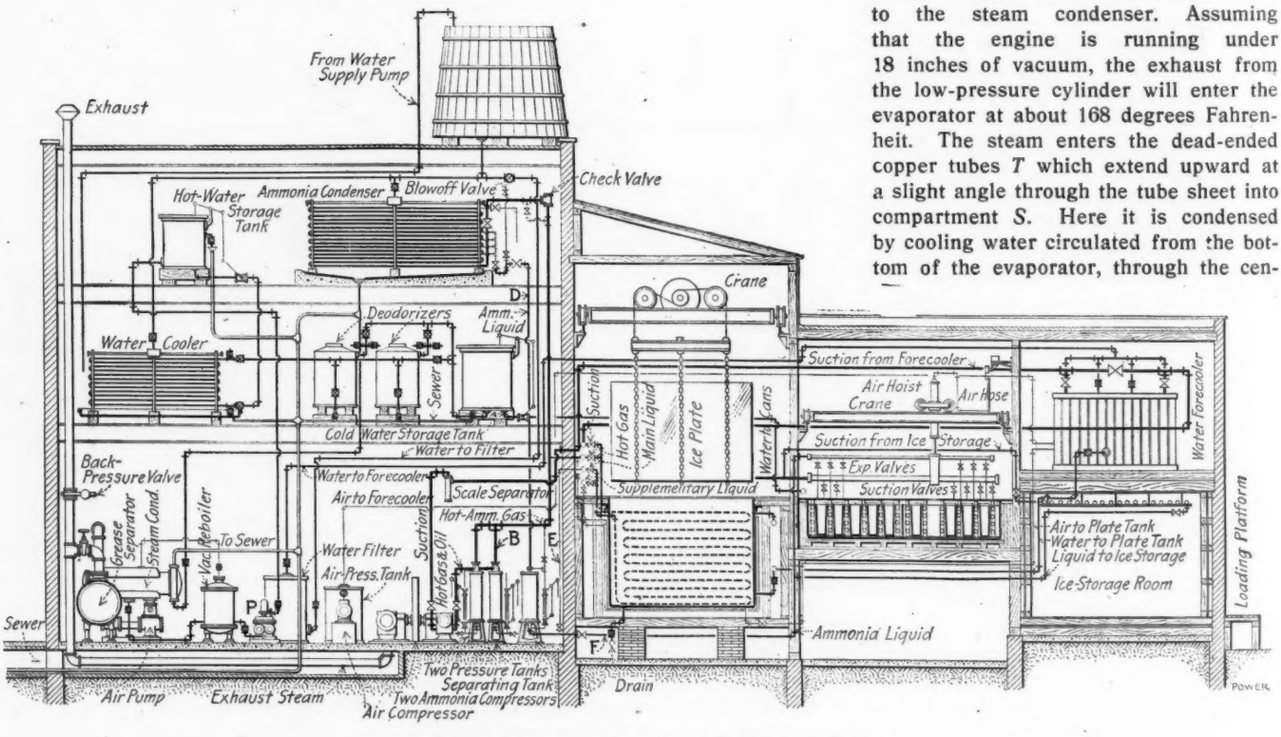


FIG. 2. COMBINED CAN AND PLATE-ICE PLANT

vacuum reboiler and enters the suction of pump *P* which discharges it into the hot-water storage tank; from here it flows through a regulating valve through the water cooler and into the cold-water storage tank from whence it is drawn to fill

the available sweet water is insufficient. For simplicity only the distilling part of the ice-making plant is shown in this illustration.

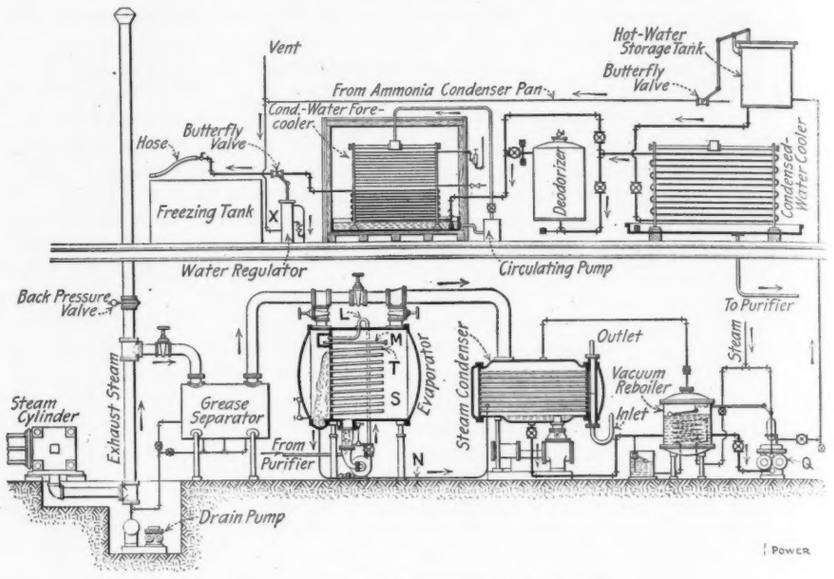


FIG. 3. VACUUM DISTILLING SYSTEM

The exhaust steam, as before, passes first through a grease separator, but in this case it also passes into an evaporator where the steam must stop, the heat being carried over by the vapor to the steam condenser. Assuming that the engine is running under 18 inches of vacuum, the exhaust from the low-pressure cylinder will enter the evaporator at about 168 degrees Fahrenheit. The steam enters the dead-ended copper tubes *T* which extend upward at a slight angle through the tube sheet into compartment *S*. Here it is condensed by cooling water circulated from the bottom of the evaporator, through the centrifugal pump, distributing pipe *L* and discharge line *M*. On the condenser side of the tube sheet a vacuum of from 24 to 26 inches is maintained by the condenser and this higher vacuum enables the heat liberated by the condensation

the water forecooler and into the plate-ice tank.

Fig. 3 represents a vacuum-distilling system, having an evaporator which provides the second means of maintaining the full capacity of the ice plant when

of every 1.15 pounds of exhaust steam to evaporate about one pound of cooling water. The cooling-water vapors are liquified in the steam condenser. Here they are joined by the condensed exhaust steam from the evaporator which is drawn through pipe *N* by the higher vacuum in the condenser, and also by a small amount of vapor drawn through the vent pipe from the top of the vacuum reboiler; condensed water from both the evaporator and steam condenser being drawn into the reboiler by the vacuum maintained in the steam condenser. The water from the steam condensed in the coils of the reboiler drains into a trap provided with a float, which as soon as the water has collected to a certain level, admits it into the suction line leading to the sweet-water pump *Q*. This pump discharges the sweet water into a hot-water storage tank, from whence it flows through the condensed-water cooler, deodorizer and condensed-water forecooler to the ice cans. In the reboiler a float valve controls the operation of the condensed-water pump, allowing it to draw water from the reboiler only when it has accumulated to a predetermined hight. In the trap from which the water condensed in the coils of the reboiler is drawn, there is a similar float valve opening only when there is a certain amount of water present. A float valve in the hot-water storage tank controls the position of another valve through which water from the ammonia condenser pan flows into a regulating device *X* which operates a butterfly valve in the sweet-water supply line leading to the ice cans and prevents the drawing of water from the storage tank below a certain level. These precautionary measures are all taken to prevent the possibility of air entering the pipes of the distilling system.

The deodorizer into which the sweet water is introduced through a strainer to insure uniform distribution through the filter bed, consists of a vertical cylindrical shell filled with charcoal covered with a second strainer which prevents any of the material from floating and entering the discharge pipe at the top. By means of a simple bypass the deodorizer can be cut out of the system for cleaning, and the sweet water fed direct from the cooler to the cans. In some instances the presence of iron salts in the water makes it advisable to supplement the deodorizer with a sponge filter.

The forecooler shown in the illustration consists of an insulated compartment in which a direct-expansion coil is installed over the distilled-water coil. Water is circulated from the pan beneath these coils and passes over the expansion coil where it is cooled to practically 32 degrees; it then gravitates down over the water coil and absorbs heat from the sweet water. As the circulating liquid is water, it is impossible to freeze up the sweet-water coils and since this circulating liquid can be chilled to the freezing point the condensed water can also be cooled to within a very few degrees of the freezing point, resulting in a great saving in freezing time, which is equivalent to increasing the capacity of the ice-freezing tanks. The reboiling of the sweet water under a vacuum at a temperature of from 200 to 204 degrees not only reduces the amount of steam required to effect the reboiling but also the amount of cooling necessary to reduce its temperature to that of the freezing tank.

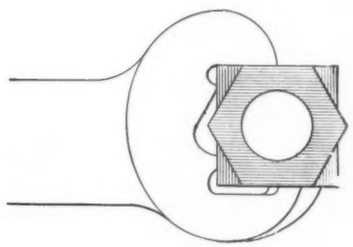
The Ratchetless Wrench

By John E. Sweet

The history of this wrench is this—I was engaged as draftsman at the Patent Nut and Bolt Company in Birmingham, Eng., and we had commenced the manufacture of finished nuts before the case-hardened ones were in vogue. On these the spanners (the English word for the American wrench) would mar them unless a mechanical fit—and this led to the design given in the illustration. As at that time I had commenced writing for *Engineering* this appeared in that paper on page 112, July 31, 1868, as follows:

"In the use of the ordinary spanner on finished nuts either one or the other of two objections has to be endured. If the spanner is a perfect fit it must be brought to the exact angle at which the nut stands before it can be entered on, and then the least dirt or bruise will make it stick or prevent it from going on altogether. If the spanner is a loose fit all the strain is thrown on the corners of the nut and perfection in workmanship in this case only aggravates the evil.

"The spanner shown above may be a perfect fit, takes a bearing on three sides of either a square or hexagon nut and will enter on freely when brought to any angle within ten degrees of the angle at which the nut may stand. Although the jaws are thick and strong, a nut



"Ratchetless Ratchet Wrench"

standing against a flange can be turned even when there is only room for the corners of the nut to pass. This principle may be carried out in different ways, and even introduced into shifting spanners; but the form here shown has the merit of extreme simplicity and yet should be used for the work for which it is designed—finished nuts—and only by men who, it is hoped will appreciate its advantages, 'finished workmen.'"

Crosshead Buckled

An item comes to us from a New England daily newspaper. It contains a mine of information which is not procurable from any other source of which we know.

Anxious to have the good work go on, we reproduce it herewith verbatim, omitting only the identifying name:

"A defective cylinder in the engine which operates the machinery of ——— mills 6 and 7 caused the mills to close yesterday afternoon and men were compelled to work late into the night in adjusting the machinery.

"The accident occurred at 2:30 p.m. yesterday. The crosshead is a short bar which acts as a sort of a hinge between the piston of the engine and the shaft of the wheel. When the crosshead 'buckles' it moves so far toward the cylinder on its backward journey that it becomes caught and cannot make its next forward movement.

"The buckling was caused yesterday by some water getting into the cylinder. A vacuum was created which allowed the crosshead to move so far back that it became wedged too tightly for it to return.

"It is fortunate that no accident of a very serious nature occurred, for if the steam had not been turned off very quickly an explosion of the cylinder might have occurred.

"As it was, mills 6 and 7 had to suspend operations for the rest of the day, and the machinists had to work on the engine late into the night. The necessary repairs have been made and the mills are running today."

Investigations to discover the causes of rusting in galvanized wire have been undertaken by the agricultural-engineering department of the University of Iowa, Ames, Ia. It has been well known that the lower wires of the fence, down among the moist grasses and weeds, where rusting action would be expected to be most active, invariably last longer than the upper wires in the dry air. M. L. King, experimentalist for the department, says he has found that these lower wires in fences of any length ordinarily carry small currents of electricity, reaching in some cases a value as high as 0.001 ampere, and sometimes showing a difference of potential of as much as one volt above ground. Such currents are absent in the upper wires, and it has been suggested, but not proved, that the greater preservative action of the lower strands is due to the suppression of local electric couples by the through currents flowing in the lower wires.—*Ex.*

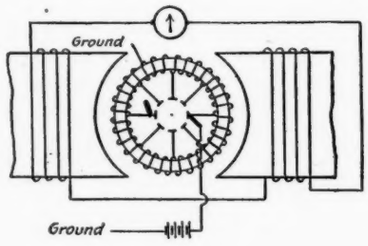
Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Locating a Grounded Armature Coil

By Francis H. Davies

The location of a grounded coil in the armature of a direct-current dynamo or motor may be very simply done by the following method: The connections should be made as per the diagram, from which it will be evident that the field circuit is entirely disconnected from the armature and its terminals are connected to a galvanometer; this should be of a fairly sensitive type—the ordinary lineman's instrument will do very well. After making this connection the brushes should be shifted to the position shown. One of them should be raised clear of the commutator and the other connected through a switch to three or four storage-battery cells; the other terminal of the battery is grounded on the frame of the



Connections for Testing

machine. When the switch is closed, current will flow through the armature winding to the core at the grounded point and the magnetic field generated in the armature core will give rise to a momentary induced current in the field winding, which will produce a kick by the galvanometer. The armature should be rotated step by step and the operation repeated as each commutator segment comes under the brush; when the segment connected to the grounded coil is reached, the galvanometer will show no indication upon closing the switch, or, at the most, a very slight one. The reason is, of course, that the current from the cells then flows through little or none of the winding, and therefore produces little or no inductive effect upon the field winding.

It is important that the brushes should be rocked into such a position that the coil connected to the commutator bar under the brush will be situated right in the center of the field-magnet pole face, in order to enhance the inductive effect. It must, however, be borne in mind that the brush position is not necessarily that shown in the diagram, which only applies to the type of armature represented. Generally speaking, it will be so, but some machines are built with the commutator displaced at an angle of about 90 degrees ahead of the winding in order to make the brushes easier of access, and in such cases the correct position will be *between* the poles and not opposite the pole-face center.

A ground will sometimes make itself apparent upon the surface of the armature by signs of burning; but if this is not the case it may be possible to locate it by applying a current of the full voltage of the machine between the commutator and the frame. If the fault is a bad one, arcing will be either seen or heard.

The Excitation of Alternators Working in Parallel

By G. E. Miles

While much has been written on the subject of the parallel operation of alternators the feature of the adjustment of excitation does not seem to have received much attention. This may be because the subject is considered so simple that it deserves little comment. However that may be, both practical and theoretical men have fallen down on this point.

I do not wish to be understood as posing as an authority on the subject but think perhaps some of my experiences and observations along this line may be of help to others.

A certain company operated two hydraulic plants situated about two miles apart, either of which was capable, during the season of high water, of carrying the load alone during the morning "shift." At station No. 1 the voltage was regulated by hand, but at No. 2, where I was located, the voltage was controlled by an automatic regulator. By visiting back and forth I soon observed that when the plants were operating in parallel, with the voltage controlled by the regulator at No. 2, the voltage at No. 1 was higher than I had been instructed to carry it by the man on the opposite shift at that plant. I also observed that the power factor was better at station No. 1.

After a few more weeks the water fell off so that both plants had to be run in order to carry the load, so another man was put on at No. 1. No. 2 was run with a waterwheel governor and automatic voltage regulator and took care of all changes in load and voltage, while No. 1 was run with a constant load and with constant excitation. The new man at No. 1 adjusted the excitation as instructed by the man on the opposite shift but I found the power factor very low at No. 2. By comparing notes over the telephone, the power factor at No. 1 was found to be high, so I asked that the excitation there be adjusted until the power factors were the same at both stations.

After a few weeks more I was transferred to station No. 1, when a discussion at once arose between the man on the opposite shift and myself, the other man insisting that I was using more excitation than was necessary when the plant had the entire load.

To make sure of my position, I submitted the question to an authority in whom I had the greatest confidence, and was advised that when two machines are operated in parallel and one of them takes care of the changes in load and voltage, the excitation of the other machine should be such as to make its current the minimum, which would be true when the machine took no wattless current from the system and delivered none to it. A trial was unnecessary to convince me that these instructions were wrong; nevertheless, I resolved on a trial. As I expected, the power factor on my machine rose to about 100 while that at the other plant went below 50.

A short time after making this trial an occasion arose for carrying the entire load on station No. 1 for a few hours. This gave an opportunity for observing the exciting current required when the load was all on one machine (the load was low enough part of the time for one machine to carry it all) and also the effect of varying the excitation when it was necessary to run two machines. I promptly found that in order to carry the same load at the same voltage and power factor it made no difference, as to the exciting current required, whether a machine was running alone or in parallel with another.

From this experience I would lay it down as a safe rule that when alternators are running in parallel the ratio of amperes to kilowatts should be the same on both machines, which, of course, gives both machines the same power factor.

LETTERS

Mr. Greer's Rotary Converters

I note that Mr. Greer in the January 31 issue takes exception to my analysis of his converter trouble, claiming that it is largely in error; also that he takes the same view as Mr. Farwell, who claims that No. 1 converter actually "hogged" the load from Nos. 2 and 3 converters.

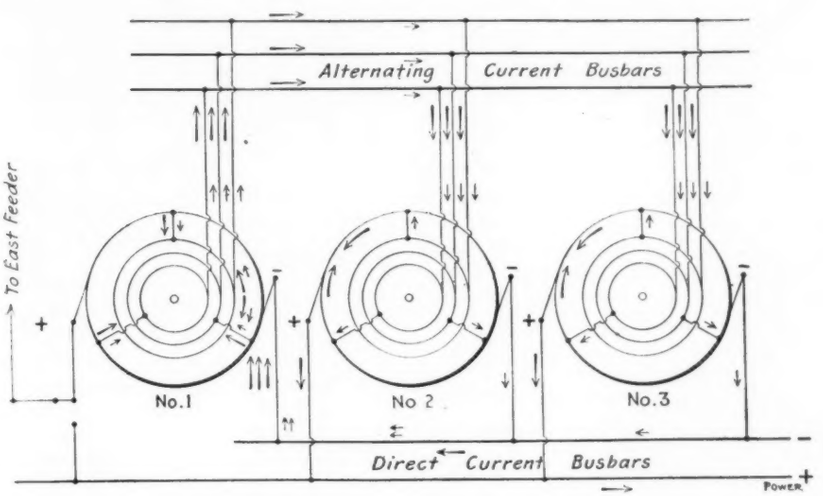


FIG. 1. MR. HARVEY'S DIAGRAM OF CIRCUITS

Mr. Greer further states in his letter that "it was not simply an exchange of current between No. 1 and the others, but No. 1 actually was carrying the load of both feeders." He undoubtedly comes to this conclusion on account of the ammeters of Nos. 2 and 3 having reversed or dropped back against the zero stops. The fact that these ammeters reversed is not proof that No. 1 took all the load.

The diagram by Mr. Harvey in the January 31 issue (Fig. 1 here) shows quite clearly the path taken by the negative current; as stated by Mr. Harvey, the negative current of the east and west feeders passed through the negative lead and armature of No. 1 converter, and in addition to this there was the excess of cross current from the negative leads of Nos. 2 and 3. As stated in my previous article and by Mr. Harvey, if ammeters had been connected in the positive leads of Nos. 2 and 3 converters they would have shown the load current of the west feeder passing through the positive leads of Nos. 2 and 3 and of necessity through the armatures of Nos. 2 and 3.

To those familiar with the principle of rotary-converter operation it will be evident that the current which passes into the armature at the negative brushes passes out on the alternating-current leads nearest to the point of negative commutation or at nearly ground potential, where the negative is the grounded side of the direct-current system. The negative current of the west feeder would therefore pass through the armature of converter No. 1, along the alternating-current leads nearest to ground potential, to the alternating-current busbars, through the armatures of the generators or the windings of the transformers supplying the busbars, thence back through the alternating-current leads nearest to the point of positive commutation in the armatures of converters Nos. 2 and 3; this current would then pass through the armatures of Nos. 2 and 3 and appear at the positive brushes at the working potential of the machines above ground.

Bearing in mind that the alternating-current generators supply all the power it will be evident from the foregoing that No. 1 converter rectifies the positive current of the east feeder and the negative current of both the east and west feeders, and that Nos. 2 and 3 rectify the positive current of the west feeder. Nos. 1, 2 and 3 all rectify the current in the local circuit. It, therefore, cannot be properly said that No. 1 took all the load of the west feeder.

The current flowing in the local circuit between No. 1 and Nos. 2 and 3 was due to a very small difference of potential between the negative brushes of No. 1 and those of Nos. 2 and 3, and, therefore, represented only a small amount of power, although the current flowing was probably of a very high value.

I agree with Mr. Harvey that the wave form of the current in the alternating-current leads between No. 1 and Nos. 2 and 3 was very much distorted and I should very much like to see an oscillogram taken under these conditions.

Referring to Mr. Farwell's December 20 article, I would say that I can hardly agree with his statement that "all necessary conditions for parallel operation existed." Suppose, for instance, that Nos. 1 and 2 were of the same size and we should attempt to operate them in parallel with the connections as shown in Mr. Greer's original diagram, reproduced here as Fig. 2. Assume that No. 1 has been properly adjusted so that trouble with local currents will not be experienced; if a load be put on the west feeder equal to the combined normal capacity of the two machines and carried for any great length of time, the armature of No. 2 will be burnt out, as it is evident from the

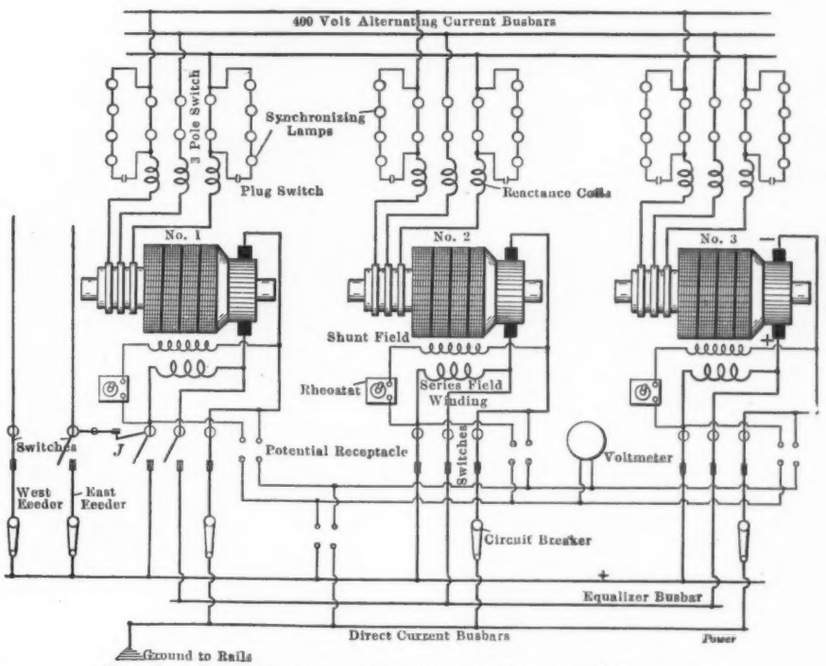


FIG. 2. CONNECTIONS OF MR. GREER'S ROTARY CONVERTERS

connections that all the positive current must pass through the armature of No. 2. This is certainly not an ideal condition for parallel operation.

If Mr. Greer still believes that No. 1 took all the load perhaps he will kindly explain how the positive current gets from No. 1 to the west feeder.

If it were possible to operate these machines in parallel with only the negative terminal of No. 1 connected on the direct-current side, using the alternating-current leads to carry the positive current, why would it not be well to go a step further and leave off the negative lead, using the alternating-current leads for both positive and negative current?

LESTER MCKENNEY.

Wappingers Falls, N. Y.

[Mr. McKenney's analysis of the occurrence is the only plausible one unless there were other conditions which escaped Mr. Greer's notice and were therefore not stated. Rotary converters cannot be paralleled in the accepted sense through their armature windings, because of the opposing electromotive forces generated therein.—EDITOR.]

Dynamo Burned Out Due to Misplaced Steam Drains

Several years ago I took charge of a small central station which ran only during the night and furnished light for an enterprising little borough. The equipment of the plant consisted of a compound-wound single-phase generator, belt driven by a waterwheel. The flume, a 40-inch steel tube, passed through part of the plant to the turbine, which had a draft tube extending down to the tail race. An auxiliary steam engine and boiler were housed in a building alongside of the main power plant; this equipment was used only in cases of emergency, and these would usually happen in the dead of winter.

I had been warned that I could expect trouble from this auxiliary equipment but never had occasion to use it until one day, a few days before Christmas, when something went amiss with the turbine. The engineer, a man on the job about three years previous, started the fire and got everything in good shape. The boiler was connected to the engine by an overhead 5-inch pipe passing through the partition between the boiler house and the dynamo room; this pipe had never been protected by a covering and naturally there was much condensation. The cylinder, valve-chamber, exhaust-pipe and water-separator drains were arranged to discharge into a terra-cotta pipe laid underground and emptying into the draft-tube pit of the waterwheel.

Toward evening the engineer got ready for the night's run, and, as it was a bitter cold day, he started to "warm up" the engine. During this process the steam escaping through the drains into the draft-tube pit was forced back into the engine room by an up draft from the tail race, and this cold air condensed the steam, which settled on the dynamo and turbine; drops of moisture settled even upon the commutator, field winding and armature. The generator was wiped as dry as possible and the engine was started slowly. As we were obliged to leave the exhaust-pipe drain open on account of the condensation caused by its passing under ground into the boiler house to the feed-water heater, steam was drawn from the draft-tube pit up to the generator and kept it pretty damp. The engine was very gradually brought up to speed, but we had to cut down the exciting voltage on account of excessive sparking at the rectifying commutator, due to the condensation on it. We finally had everything working in good order, apparently, and brought the generator up to its full voltage slowly; while looking after the brushes, however, the armature suddenly became ablaze. We shut down as quickly as possible, but found that the whole armature was damaged; where it was not burned it was punctured.

All this was caused by placing the drain pipe wrong, principally to save in the cost of installation.

The trouble was subsequently abolished by changing the position of the drain outlet.

A. J. ALTHOUSE.

Birdsboro, Penn.

Exciting an Alternator from an Arc Dynamo

An electric-lighting and pumping station where I was employed a few years ago was equipped with a 250-horsepower Corliss engine, a 2000-volt direct-current arc-light machine and a 100-kilowatt 1100-volt alternator, both dynamos belt driven from a line shaft. A shutdown would cause the city to be thrown completely in darkness and stop several small motor-driven factories, which were entirely dependent on the plant for power.

Early one morning the lights in the plant went out, and the trouble was finally located in the exciter which supplied current to the field winding of the alternator. There was a broken wire in the armature winding and it was so far in the coil that I could not splice it; bridging across the commutator bars was not feasible because the winding was grounded on the core.

As a last resort, I tried the following expedient, which worked very well temporarily: After rocking the brushes on the arc machine as far forward as possible and blocking them in that position, I ran two wires from the direct-current switchboard panel to the exciter terminals on the alternating-current panel, after disconnecting the exciter leads, and excited the alternator from the arc-light machine. The object in blocking the arc dynamo brushes forward was to prevent excessive voltage at the terminals of the alternator field winding.

M. V. MILLER.

Fort Snelling, Minn.

Mounting Trolley Wire Hangers in Mines

I have had a good deal of trouble with trolley-wire hangers in mines. Expansion bolts set in the ordinary way will not "stay put" because the rock soon becomes soft and the hanger is then easily pulled down. Finally I set the bolts in a mixture of cement and sand, half and half, enlarging the bolt hole and nearly filling it with the mixture, then pushing the bolt up in the hole, tightening the wedge and cementing it around the bottom. The result is a neat, inexpensive and permanent job; the hanger bolts do not pull out any more.

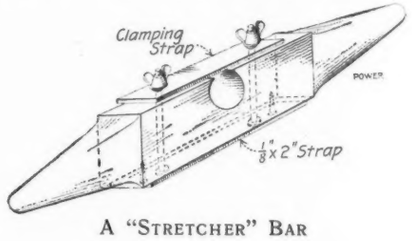
JOHN CULLOM.

Collinsville, Ill.

Another Armature "Stretcher"

Some time ago I saw a description in POWER of a frame made up of pipe fittings and used for carrying armatures. I had tried such an arrangement but had to give it up because I could not use it to advantage on account of narrow doorways and short turns and short flights of steps in the office building where our plant is.

I then made a pair of stretcher beams like the accompanying sketch, which I find to be more convenient. They are easily and cheaply made, do not take up much room and can be juggled around



A "STRETCHER" BAR

short turns. I made my pair out of the pine cross arm of a telegraph pole, which I sawed into two lengths, making each beam 28x5x2⅞ inches.

I shaved each end down to make a good hand hold, cut a circular "notch" across the center of the top edge and reinforced the bottom edge with a piece of ⅛x2-inch strap iron. The two ⅜-inch bolts which pass through the beam serve to hold the armature shaft in the circular opening, a clamping strap being forced down on the shaft by the thumb nuts on the through bolts.

I have six armatures, all of the same size, weighing nearly 400 pounds each, and with two men and one of the beams ahead and the same behind we can carry an armature very comfortably.

T. F. MCFADDEN.

Columbus, O.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Elementary Lectures on the Gas Producer

By Cecil P. Poole

Usefulness of the Economizer

In one of the early lectures it was explained in a general way that the air which is admitted to the fuel bed is first passed through an "economizer," which heats it. The study of specific heat has

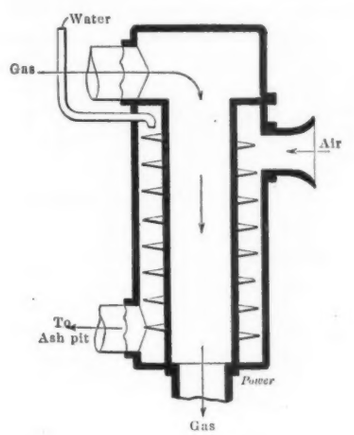


Fig. 2. Combined Economizer and Vaporizer

since put the student in position to understand more definitely the advantages gained by this process.

When the gas leaves the top of the fuel bed it is at a rather high temperature—somewhere around 700 to 800 degrees ordinarily. This is too high for use in a gas engine for reasons that will be discussed at some future time; for the present it is enough to say that the gas supplied to an engine should be as cool as possible.

If the gas should be cooled entirely by the water spray of the scrubber, a large part of the sensible heat in the gas would be simply carried off in the scrubber water and thrown away. Instead of doing this, some of the sensible heat is transferred from the gas to the air passing to the ashpit and carried back into the generator, thereby avoiding the taking of just that much heat from the fire zone to heat the air.

The saving effected by preheating the air with the outgoing gases will be made clear by considering the details of a practical case. Suppose a generator 3 feet 3 inches in diameter (across the fuel bed) gasifies 100 pounds of anthracite coal an hour; also, suppose that the coal contains 78 per cent. of fixed carbon, 1¾ per cent. of hydrogen and 5 per cent. of moisture, the remainder being noncombustibles.

Further suppose that carbon monoxide is made with 66 of the 78 per cent. of carbon and carbon dioxide with the remaining 12 per cent., that one-fourth of the oxygen required for operation is obtained from steam and the remaining three-fourths from air. The operations will figure out as follows:*

Air supplied per hour, lb.	374
Steam supplied per hour, lb.	33¼
Steam made per hour, total	38¼
Gas made per hour, lb.	492
Refuse rejected per hour, lb.	15¼
Heat energy in the gas, B.t.u.	980,100
Sensible heat per degree of temperature of the gas, B.t.u.	138½

The air contains

$$374 \times 0.77 = 288$$

pounds of nitrogen and argon, air being 23 per cent. oxygen, 76 per cent. nitrogen and 1 per cent. argon. For simplicity the argon is considered as nitrogen.

From the foregoing, the gas characteristics are as follows:

	Pounds.		Cubic Feet at 750°.		Per Cent. by Vol.	Sensible Heat per Degree.	Heat Energy, B.t.u.
CO	154	=	4,854	=	28	154 × 0.248 = 38.2	154 × 4,350 = 669,900
H	6	=	2,584	=	15	6 × 3.409 = 20.5	6 × 51,700 = 310,200
CO_2	44	=	882	=	5	44 × 0.217 = 9.5	0
N	288	=	9,050	=	52	288 × 0.244 = 70.3	0
Totals	492	=	17,370	=	100	138.5	980,100

Specific heat = 138.5 ÷ 492 = 0.2815.

The gas will leave the fuel bed at a temperature of about 785 degrees, Fahrenheit. Suppose that the air takes out of it only enough sensible heat to reduce its temperature 300 degrees. That will amount to

$$300 \times 138\tfrac{1}{2} = 41{,}550$$

B.t.u. per hour, because there are 492 pounds of gas delivered per hour and the specific heat is 0.2815, making the sensible heat per degree, for the entire quantity,

$$492 \times 0.2815 = 138\tfrac{1}{2}$$

B.t.u. (See details in the footnote.)

As the heat energy in the gas delivered to the engine is 980,100 B.t.u. per hour, it is evident that the heat saved by the economizer (41,550 B.t.u.) amounts to about 4 per cent. of that used in the engine. That it is a clean saving is undeniable; if the air were not partly heated by the outgoing gases it would have to be entirely heated by the fire in the generator and the heat in the gas would be thrown away in the scrubber water.

The 41,550 heat units taken out of the gas by the air will raise the temperature of the latter 468 degrees, because the specific heat of air is 0.2375 and there are 374 pounds affected by the 41,550 heat units;

$$0.2375 \times 374 = 88.825$$

B.t.u. required to raise the temperature of the 374 pounds one degree and

$$\frac{41{,}550 \text{ B.t.u.}}{88.825 \text{ B.t.u. per degree}} = 467.77$$

degrees, or practically 468.

*The figures given are derived in this way:

Oxygen required to burn 66 pounds of carbon to carbon monoxide, $66 \times 1\tfrac{1}{3} = 88$ lb.
Oxygen required to burn 12 pounds of carbon to carbon dioxide, $12 \times 2\tfrac{2}{3} = 32$ lb.
Total oxygen required, $88 + 32 = 120$ lb.
Oxygen supplied in steam = 34 lb.
Remainder supplied in air = 86 lb.

Air required to supply 86 lb. of oxygen, $86 \div 0.23 = 374$ lb.

Steam required to supply 34 lb. of oxygen, $34 \times \frac{9}{8}$ = 38¼ lb.
Water in the coal = 5 lb.
Steam brought in with air = 33¼ lb.

Hydrogen in 100 lb. of coal = 1¾ lb.
Hydrogen in the total of steam, $38\tfrac{1}{4} \div 9$ = 4¼ lb.
Hydrogen in delivered gas 6 lb.

Effect of the Vaporizer

The vaporizer also effects an important saving when it is arranged to use the heat of the outgoing gases to make the steam, as in the types illustrated by Figs. 2, 3 and 4. In all three of these, the steam is made by the heat from the generated gas. Figs. 2 and 3 show combined vaporizers and economizers; in the type represented by Fig. 4 the air is preheated in an economizer before entering the vaporizer and picking up the steam.

Consider the case previously assumed. The generator was supplied with 33¼ pounds of steam per hour, and in order to make steam at this rate from water

of, say, 62 degrees temperature, 37,240 B.t.u. must be supplied per hour, because it takes 1120 B.t.u. to heat one pound of water from 62 to 212 degrees and evaporate it into steam at atmospheric pressure.

If these 37,240 heat units were not supplied from the sensible heat of the gas, they would have to be supplied from some other source; if they were so supplied, it would cost something to supply them, whereas they are there in the gas, ready for use, and would be thrown away if carried into the scrubber.

Adding this saving of 37,240 heat units

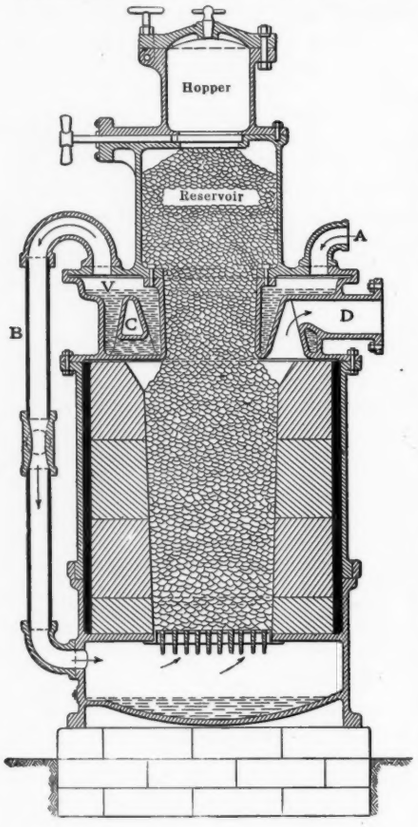


FIG. 3. VAPORIZER BUILT IN TOP OF GENERATOR

by making steam to the 41,550 units of sensible heat utilized in heating the air makes 78,790 heat units per hour "rescued" from the gas on its way to the scrubber. This is the equivalent of

$$\frac{78{,}790}{2545} = 31$$

horsepower, theoretically, or nearly 8 actual brake horsepower at the engine.

THE SCRUBBER'S SHARE

When the gas finally reaches the scrubber its temperature will be much below 485 degrees, because of the use of sensible heat in making steam. As just shown, the total sensible heat used in heating the air and making the steam amounts (in the assumed example) to 78,790 B.t.u. an hour. The temperature of the gas will be reduced, therefore, by

$$\frac{78{,}790}{138\frac{1}{2}} = 568.9$$

degrees, instead of 300 degrees, and if we consider the effect of radiation it will be safe to assume a reduction of 570 degrees by the time the gas enters the scrubber. Its temperature then will be 215 degrees.

Suppose it is desired to cool the gas to 85 degrees in the scrubber. That is a temperature reduction of

$$215 - 85 = 130$$

degrees and it means that the scrubber water must take 18,005 heat units out of the gas per hour, because the sensible heat of the gas per degree* is 138½ B.t.u. and the temperature change is 130 degrees;

$$138\tfrac{1}{2} \times 130 = 18{,}005.$$

As the gas is to be cooled to 85 degrees, the temperature of the water cannot rise above that point; say it rises to 82 degrees and is at 62 when it enters. With this rise each pound of water will absorb 20 heat units and as there are 18,000 heat units to be absorbed per hour, there must be

$$18{,}000 \div 20 = 900$$

pounds of water passed through the scrubber per hour. In practice, a good deal more than this would be needed because it is impossible to make each drop of the water come into contact with its share of the gas.

Now, 900 pounds of water is not such a tremendous lot; at 62 degrees temperature it is 108 gallons. But suppose for a moment that the gas had not been cooled in the economizer and the vaporizer before reaching the scrubber. Instead of taking out 18,000 heat units an hour the scrubber would have to take out that much plus 78,790, or 96,790 heat units an hour. This would require about 580 gallons of scrubber water per hour instead of 108 gallons.

It would also be necessary to use a large scrubber, because efficient contact could not be obtained between the gas and five times the normal quantity of water in the same sized scrubber.

However, this final consideration is of minor importance, not only because it is indefinite but because the saving of heat makes it advisable to preheat the air and make the required steam with the waste heat that is in the gas when it leaves the fuel bed.

VAPORIZING IN THE ASHPIT

The figures just given show very clearly that the practice of making steam in the ashpit, which is necessary with some forms of generator, is rather uneconomical. A gas-producer attendant once told me, with the air of having discovered an important labor-saving feature in producer operation, that he had found the vaporizer unnecessary; all he had to do was to throw a couple of pailfuls of water in the ashpit the first thing in the morning and another one just before the factory started up after the noon hour. The heat radiated downward from the fire zone vaporized the water as the generator needed steam and he did not have to bother with regulating a flow of water to the vaporizer.

This plan of working has only one merit—it is a little easier to dump bucketfuls of water in the ashpit than to adjust the small drip in the water supply to the vaporizer. It entails two serious disadvantages: waste of heat and irregularity of gas quality.

It might seem that there is no waste of heat because the "heat is already in the ashpit," as my operator friend expressed it. The answer to that is that it is largely untrue. There is some heat in the ashpit, of course; it is warmer there than in the outside atmosphere, but the heat normally there is not enough to make the steam required by the generator.

In order to allow enough heat to pass down from the fire zone to water on the

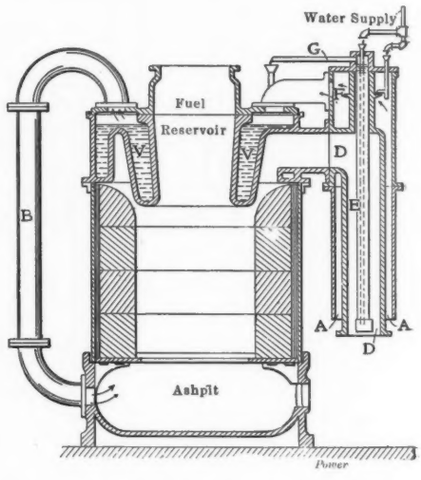


FIG. 4. BUILT-IN VAPORIZER AND EXTERNAL ECONOMIZER

floor of the ashpit and vaporize as much as the generator needs, the bed of ashes beneath the incandescent coal must be kept thinner than it would otherwise be; this will permit more heat to escape from the fire than would get out under proper conditions. Moreover, with water in the ashpit the temperature there will be lower and, consequently, the flow of heat from the fire into the pit will be greater than if no water were there. Every heat unit taken from the fire *unnecessarily* is wasted, no matter what you do with it.

The quality of the gas is made irregular by this practice because more heat will flow from the fire to the ashpit immediately after ashes are shaken or poked out of the generator into the pit than immediately before; consequently, more hydrogen will be put into the delivered gas. As the ash bed beneath the fire zone increases in thickness, due to

*Sensible heat per degree is the number of heat units that must be added to a given quantity of gas to raise its temperature one degree, or taken from it to lower its temperature one degree.

the combustion of coal, the heat passing from the fire to the water each minute or hour will gradually decrease, causing a decrease in the water evaporated and a resulting decrease in the proportion of hydrogen in the delivered gas.

In short, when the fuel bed is poked down or the grate shaken, the proportion of hydrogen in the delivered gas suddenly increases; then it gradually decreases until the next poking or shaking is done. And an increase in the proportion of hydrogen usually means an increase in the proportion of carbon dioxide and a corresponding *decrease* in carbon monoxide.

The reason for this is that increasing the proportion of hydrogen can be done only by increasing the proportion of steam passed through the fire; this reduces the temperatures of both the fire and the decomposition zones, and the reduction of temperature almost always reduces the percentage of carbon monoxide and increases that of carbon dioxide, as explained in the last lecture (January 10, 1911).

An Engine that Generates Its Own Gas from Coal

Another stride toward ultimate simplicity has been made. A M. Low, an English engineer, has devised an engine which generates from coal the gas by which it is driven. The accompanying sketches illustrate the more important constructional features of a small experimental engine that has been in operation some time.

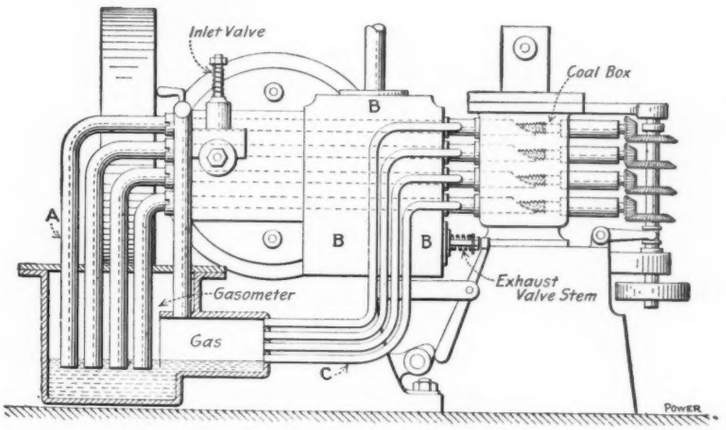


FIG. 1. REAR END OF ENGINE WITH GENERATOR ATTACHMENT

Fig. 1 is a view of the "breech" end of the engine, which is of the single-cylinder single-acting type with a horizontal cylinder. Several tubes pass horizontally through the combustion space of the cylinder, from the coal box at the right to the water-sealed gas box at the left; these tubes, where they lead from the cylinder to the gas box are indicated by the letter *A* and at other points by dotted lines. The tubes pass also through a distillation box *B*, where they are subjected to the heat of the exhaust gases as the latter leave the cylinder.

The coal box is filled with crushed coal and this is forced into the tubes just mentioned; when it reaches those parts of the tubes inclosed in the distillation box, the heat of the exhaust gases distils out the lighter volatiles in the coal and these are immediately taken out by the small branch pipes *C* and carried to the gas box. When the heavier constituents in the coal enter the tube reaches which are located in the combustion chamber, they are heated to a very high temperature, of course. At this point, steam and air blown in by jets supplied with steam from the water jacket of the cylinder (this connection is shown semi-diagrammatically in the horizontal section, Fig. 2) act upon the carbon exactly as in a gas generator, forming hydrogen, carbon monoxide and carbon dioxide.

These final gases pass on to the gas box, which is really a small holder, where they mix with the volatiles previously distilled out of the coal. From the holder the gases pass to the inlet-valve chamber of the engine, where they are mixed with air, in the usual way, before entering the cylinder.

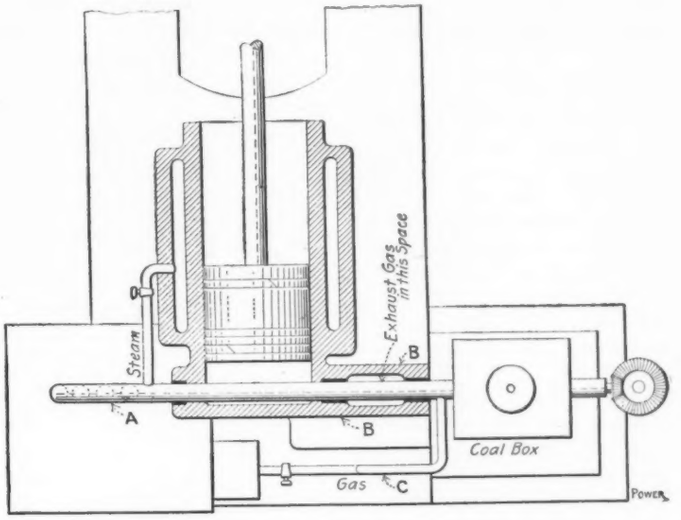


FIG. 2. HORIZONTAL SECTION THROUGH CYLINDER

The mechanism for feeding the crushed coal into the gas-making tubes consists of a number of archimedean screws, each arranged as represented in Fig. 3. In the engine illustrated by Fig. 1 there are four gas-making tubes; coal is forced into each of these by an individual screw and the four screws are gear-driven from a single vertical shaft. This shaft is driven through an adjustable clutch by a belt from some part of the engine mechanism and the governor controls the clutch so as to vary the supply of coal according to the load conditions.

The inventor claims that his experimental engine has shown a fuel consumption of 0.4 of a pound of coal per brake horsepower-hour; also that the coal is "cracked" so quickly by the high temperature that all byproducts can be passed through the engine and discharged, without any difficulty. Several weeks of running, he states, have failed to show any tar or lampblack. The producer part of the outfit works on practically the "flash" system, the coal being fed in minute quantities as needed and immediately gasified.

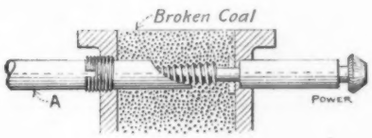


FIG. 3. COAL FEED

We are indebted to *Gas and Oil Power* for the general information and the illustrative material utilized in the preparation of this article.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Pumping Water by Air

A State institution has a well that is 135 feet to the water, and it is 57 feet to the top of a tank into which the water is to be delivered. They wished to do the work by means of air, and had a 15-horsepower gasolene engine and an 8 and 4 by 8-inch two-stage air compressor set up, the latter to run 265 feet piston travel per minute. The engine had a 34-inch pulley and the air compressor had a 42-inch pulley.

The air line extended down 285 feet below the water level.

As the engine would not do the work, I decided, after a night's sleep, to make it do it. The intake was bushed from 3 to 2 inches and a close nipple and a globe valve were screwed in the 2-inch opening. The valve was partly closed and the trick was done. By opening the valve, all the air that the engine could pull could be admitted and all the water that the 15-horsepower engine could supply air for was obtained. I think that if the pulley on the engine were reduced to 24 inches in diameter, so the intake could be opened to its full size, better results might be obtained. Would this be the means of producing any more water, the engine running at the same speed? I would like to hear from those who have had a similar experience.

H. T. FRYANT.

Mobile, Ala.

Distant Control Valves and Oil Indicating Scheme

During a recent visit to a large pumping station I was much interested in the arrangement made use of for operating the service gates and heavy valves in the neighborhood of the station. Many of them were of several tons weight and all were operated by hydraulic pressure from the engine room.

The water used in the operation of the gates was pumped to an ordinary pressure tank where a pressure of 160 pounds per square inch was maintained. It was admitted to the cylinder at the top or bottom as desired, by a four-way valve, which also serves the double purpose of admitting pressure upon the side of the piston necessary to operate the gate, and that of opening a means of escape for the water already contained in the cylinder to the return tank.

The operator can control the gates with perfect ease by means of a small hand lever upon the control board. The opposite end of this lever is extended beyond the valve stem a few inches and serves as a pointer indicating upon a quadrant which way the four-way valve is open.

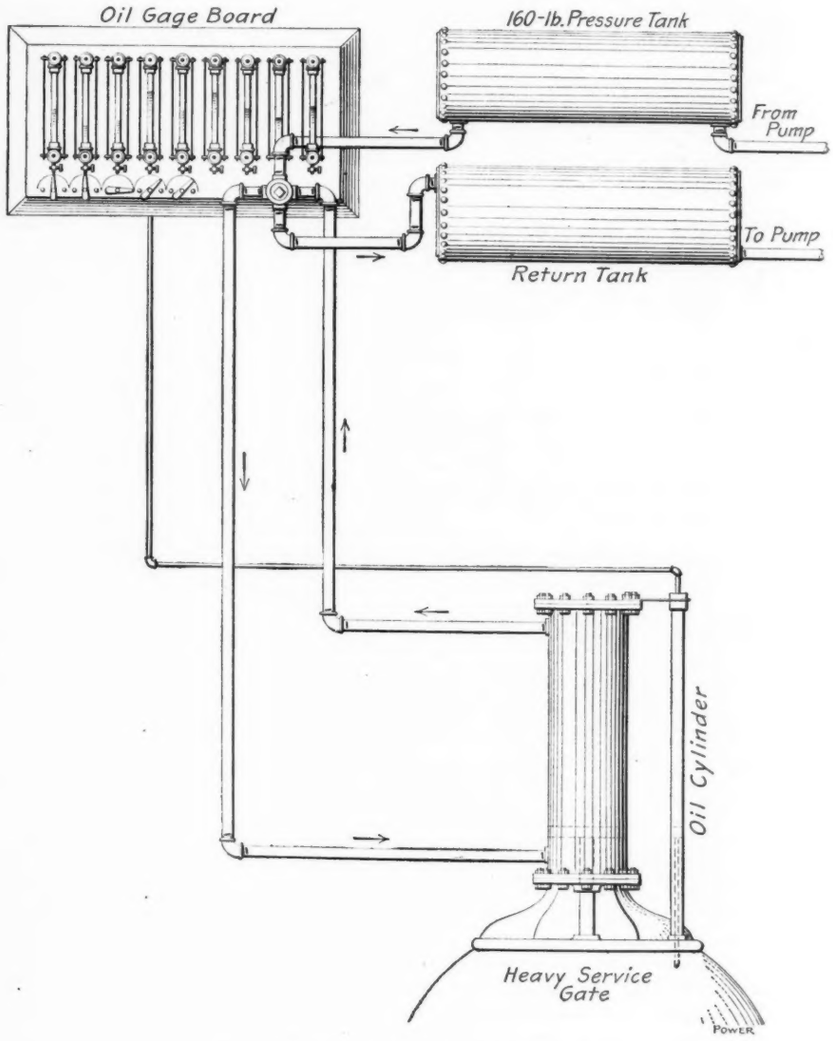
An interesting oil-indicator scheme has also been worked out. A tail rod is attached to the valve disks in the conduits, which plays up and down with them.

This rod operates a piston in a small cylinder of the same length as the large ones.

This cylinder is filled with oil, also the pipes which run to the control and gageboard. There is a gage glass for each valve where its position is plainly indicated by the hight of the oil.

When a gate is open, the corresponding oil gage glass will be nearly full. The tail rod forces the oil up out of the small piston and when it is closed the conditions are reversed.

A little difficulty was encountered when



SHOWING PIPING OF INDICATING DEVICE

the system was first installed, due to air bubbles in the oil, which would give an incorrect reading, and some experimenting also had to be done before the proper oil displacement could be gotten at to keep the range of altitude right for the glasses. The first difficulty gradually adjusted itself after the system of piping was opened at the highest point. The second trouble was overcome by the establishment of a common reservoir for all the lines at the top of the gageboard. It serves as a sort of an overflow tank and replenisher. The accompanying sketch gives an idea of the scheme. One pump, pressure tank, return tank, etc., are used in common for handling all heavy gates about the station. Only the four-way valve and piping for one are shown.

EDWARD T. BINNS.

Philadelphia, Penn.

Reduced Discharge Pipe Increased Motor Load

In the plant where I am employed, there is an 8 and 7 by 10-inch steam pump and a 5½x8 triple-plunger power pump, driven by a 10-horsepower motor. This outfit furnishes the town with water, but the former pump is used only in case of emergency.

Upon taking charge of this plant I looked over the pump-piping layout and found the suction and discharge pipes to be 4 inches in diameter. The discharge pipe from the power pump had been reduced to 3 inches by putting a bushing in the pump flange and one in the main discharge pipe with a nipple between.

The old pipe was removed and a new 4-inch pipe was put in its place, and it was found that the motor load was reduced from 6.2 to 5.2 kilowatts per hour. This was partly accounted for by the fact that the old pipe was badly scaled.

T. K. LEE.

Benson, Minn.

Temporary Pipe Repair

A 2-inch supply pipe to an overhead tank was allowed to freeze and when thawed out was found split open for about 30 inches. The tank was situated at the top of a steel tower some 70 feet in hight.

This 2-inch supply pipe, a 3-inch discharge pipe and two 1½-inch steam-heating pipes ran up the center of the tower inside a wooden casing. The leak was about 50 feet from the ground.

Owing to the close proximity of the other pipes it was not possible to use the pipe cutters, and it seemed that the only alternative was to remove the casing and pull down a long run of pipes.

However, it was decided to put a patch on the pipe until the weather should become milder. A piece of 2½-inch pipe, 36 inches long, was procured and cut lengthwise into two equal parts.

One-half was retained and lined with sheet rubber. This was placed over the leak and drawn firmly up to the pipe by means of four clamps placed about 10 inches apart.

This effectually stopped the leak.

WILLIAM WATT.

Lambton Mills, Canada.

A Condenser Accident

A large compound jet condenser had been used in a power station for about five years. The high- and low-pressure piston rods were connected by means of crossheads and wristpins on the end of a rocker beam that was pivoted in the center.

The valve gear was automatic and often caused the pump to hang up whenever the valve stuck, which reduced the vacuum. Requests had been made to have a valve rod connected to the beam, but without success.

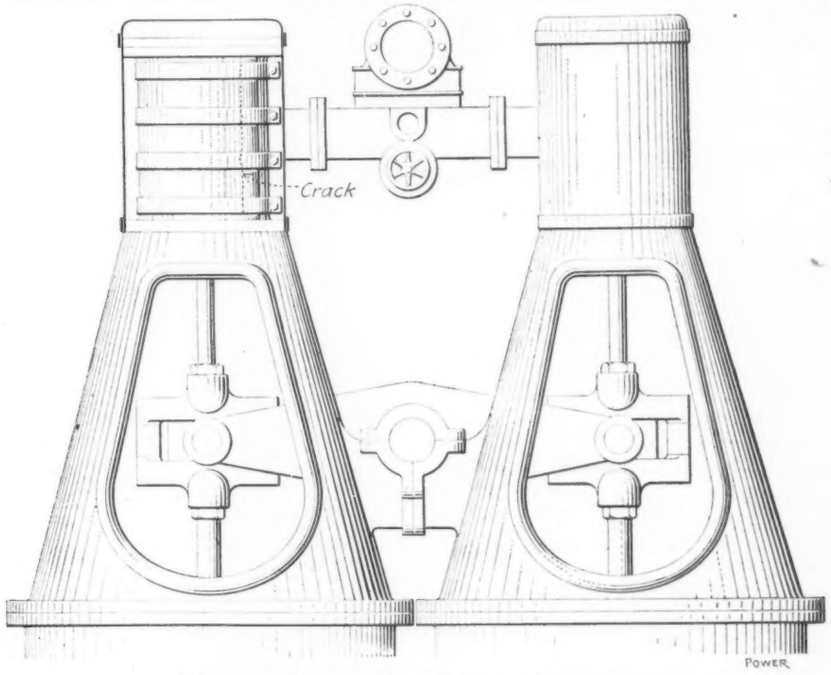
A cylinder head had been blown out of the high-pressure cylinder soon after it had been installed. Some time later a new cylinder was put on because a thin wall had been discovered when drilling a hole to allow a quicker flow of steam to aid in operating the main valve. Everything went as usual after the new cylinder had been put on and the men predicted the pump would always be a hoodoo to the plant, owing to its design.

Last winter it refused to work and an examination revealed that the low-pressure cylinder had cracked on one side the length of the cylinder.

Temporary repairs had to be made and as the low-pressure cylinder worked under a low steam pressure, it was decided to put a strip of gasket rubber over the crack and a flat strip of iron over the gasket to hold it tight. Bands fitted with draw bolts were made of such a length as to go around the cylinder over the strap. They were then bolted tight, as shown in the illustration, and made the crack tight enough for service, although there was some leakage at the flanges.

The condenser was run this way for nearly six months when two new high-pressure cylinders were put on, also, a new valve and steam chest, the valve having a rod connected to the beam, which made the action of the valve more regular and positive with each stroke.

Just what caused the cylinder to crack is not known, but when the piston, which was of the solid type, was taken out, the lower packing ring was found broken and a piece had worked over into the other slot where the ends of the ring were found to have worn thin. The thin end of the broken ring extending over the edge of the slot had become wedged between the piston and the wall of the cylinder. When the piston was on the downward stroke the force from the high-pressure cylinder transmitted through the beam, together with the weight of the descending bucket, probably caused the fracture. But, how the piece of ring got over from the bottom slot into the top one, is most mysterious, as it could not have overriden the counterbore 6 inches, the thickness of the piston, or even enough to allow the top ring to spring out, or it would also have been broken.



HOW THE CRACKED CYLINDER WAS REPAIRED

R. A. CULTRA.

Cambridge, Mass.

Manhole Gaskets

Perhaps my method of putting manhole gaskets on manhole plates will be of interest. I take any good make of 5/8-inch round gaskets for the manhole, but, before using, the plate is cleaned with a sharp tool, and a mixture of either red or white lead and boiled linseed oil with a consistency of a thick paint is applied to cleaned surface. The gasket is cut to the proper length and the lead tube inserted in both ends and the joint taped.

Then a coating of graphite and cylinder oil is applied on the exposed side of the gasket and the plate is then placed in position in the manhole.

Before removing the plate again, I take a sharp tool and mark it so as to always replace it in the same position.

When removing the plate the gasket will stick to it, and it is only necessary to trim off the overhanging parts of the gaskets and apply a coating of graphite and cylinder oil before replacing it.

I have used this method for many years with success and have used the same gasket twenty times or more, without leakage, before replacing with a new gasket.

E. L. Morris.

Salem, Va.

Boiler Setting

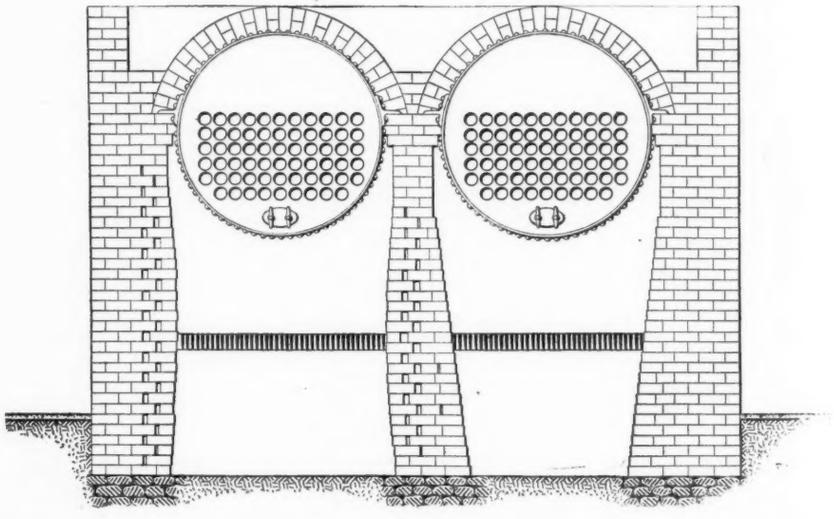
Perhaps a job of repair work which was recently done on the brick settings of some horizontal tubular boilers may be of interest. There were four 5x18-foot horizontal return-tubular boilers, set in batteries of two, each boiler supported by lugs resting on wall plates in the usual way.

For some reason the walls were never properly built, the furnaces having been made with thirteen courses of firebricks on the side walls before any headers were reached, and the bridgewalls had been faced with bricks laid flatwise to the grate surface. The side walls of the combustion chambers were laid up with common red brick, the joints being from 3/8 to 3/4 inch thick, and considerable lime had been used in the mortar. Further, from twelve to fourteen courses of bricks had been laid up before any headers were tied into the wall. As a result the mortar worked out of the walls and the heat caused the walls to bulge in about 6 or 7 inches, and one side wall fell into the combustion chamber before the boiler could be laid off for repairs.

The furnaces were first repaired by taking down the wall and rebuilding the lining, cutting in a course of headers at the sixth course above the grates and using a good grade of firebrick, and fire clay so thin that it could be put on very thin, which allowed the bricks to come practically brick to brick, only clay enough being used to fill in the unevenness of the bricks.

The rear wall was quite another proposition, as it was not advisable to tear down the whole of the wall if it could be avoided, although that was what I recommended be done and an entire firebrick wall be built in its place.

The combustion chamber of these boilers had been carried down to within about eight inches of the ashpit level as there were many reasons for not entirely rebuilding the wall. As much of the face of the wall as was deemed safe was removed, after the boiler had been blocked up to prevent accident, and at the bottom of the combustion chamber the wall was brought out 14 inches and then built up to a hight nearly to the lugs and under a course of headers, above which the wall was sound. This wall was stepped in about one-quarter inch for each course and was all of firebrick, laid close together and headers every fifth course. The old red bricks were used as backing to the firebricks. These walls were carried from the bridgewall back to the rear wall on all four boilers.



Condition of the Old Furnace — How the New Furnace was Bricked

The bridgewalls were taken down far enough to allow firebricks to be set in edgewise and was lowered 4 inches, so that it is now 13 inches from the boiler shell, whereas, before it was but 9 inches. The changes can perhaps be better understood by referring to the right-hand view, which shows the side walls as they are at present.

These boilers steam much easier than before and lowering the bridgewall has increased the draft considerably. As the center wall has a batter on both sides, built entirely of firebrick, it is expected that these repairs to the combustion-chamber walls are good for the life of the boilers, and so far the results have been better than was expected.

Return-tubular boilers are set too low in most cases for soft coal. From my observation a 72-inch boiler should be set at least 40 inches if not 48 inches above the grate bars, and plenty of room left for the combustion of the gases.

One experience I had some few years ago, on some large boilers which were set high, has convinced me that any engineer having the matter of setting new boilers in hand can do no better than by setting them high above the grates for soft coal, with good, thick walls and headers every fifth or sixth course, thin joints on the outside walls, all firebrick surfaces practically rubbed together, a low bridgewall and plenty of room between the rear wall and the rear head of the boiler. The first cost may be a little more, but it will be found a first-class investment.

William S. Trofatter.

Boston, Mass.

Starting a Plunger

An old, rusty steamboat doctor had been idle for over a year, and the plungers were stuck tight.

Every available suggestion was tried but it would not "break loose" even with a heavy leverage upon the flywheel, and even coal oil had not touched every part of the surfaces in contact, though a large quantity had disappeared.

Someone tucked some oily waste around the top of the plunger and then set fire to it, which was followed by an explosion. No damage was done and the plunger was loosened.

The same scheme was carried out on the other plunger, but less oil was used and the waste was put in and set on fire before much oil had time to soak down.

This method of loosening a pump plunger is not to be recommended, and is more or less dangerous.

Lloyd V. Beets.

Nashville, Tenn.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Expansion Valve

Of late several letters have appeared in POWER under the above head. Some of the writers seem to be under the impression that engineers apply the term "expansion valve" to the feed valve through ignorance of the principles of refrigeration, but that is not the case. We get the term from the builders of ammonia valves and fittings, and the use of it is no more incorrect than the use of such terms as "expansion coil" or "flooded system."

R. E. HENSLEY.

Hico, Tex.

Blowoff Piping

In the December 20 issue, Edward Hamilton described the blowoff arrangement for his boiler. O. B. Critchlow in the January 24 issue criticizes it, claiming that it is in no way satisfactory to him. He thinks that all of the circulation would be due to the condensation in the small riser, which would be of no practical value. I think that he is in error, for in my experience the device works satisfactorily. Further, it is recommended by boiler inspectors.

W. STEINDORFF.

Brooklyn, N. Y.

The Benefit of Organization

I have been following the items in POWER on engineers' wages. Strive as we may our wages will never go up, unless we all join and form an organization of some kind, and "stick together." Nowadays, if an engineer demands more pay, no matter how good a man he is, the employer will say, "Well, if you can't work for the wages you are getting, we can get someone that will work for even a little less." He will not stop to think, "Is my next engineer going to be capable of handling my expensive machinery?"

I have been in the employ of one company for the last eleven years and have been engineer for six years in charge of one 150-horsepower Corliss engine, one 75-kilowatt generator, seven motors, ranging in capacity from ½ to 12 horsepower, and one 200-horsepower water-tube boiler. I have all of the repair work to look after, and still can not convince my employer that I am worth more than some of the men working in the factory, running one machine for ten hours a day.

But, then, whose fault is it? Surely we cannot blame the employer. In a way, it is the engineers' fault. As I said before, why not stick together and form an organization. Then we can demand higher wages, and not until then.

CHARLES GOTSTEIN.

Algoma, Wis.

Underground Pipe Protection

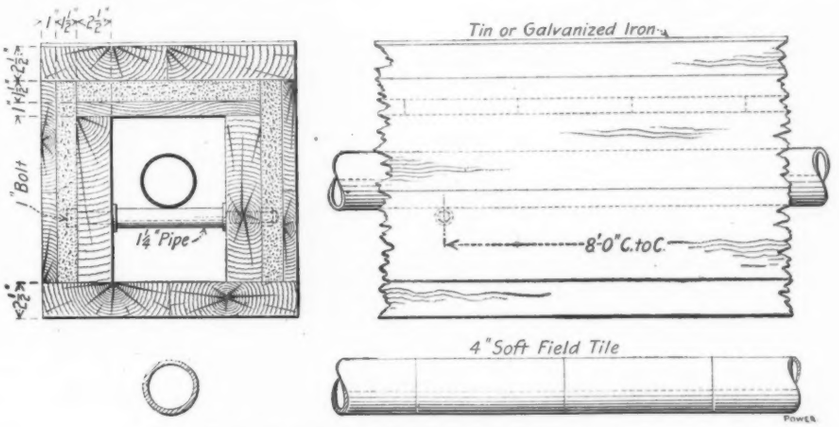
Having seen several articles in POWER on underground steam-pipe protection, I submit the accompanying sketch showing the construction we have used with good results.

Opinion may differ as to the proper size of the space for the pipe. For a 4-inch pipe the inside width should be about 8 inches, the inside depth about 12 inches and the rollers about 4 inches above the bottom. The 1½-inch insulation space at the sides may be filled with shavings to good advantage. If desired, the top of the box can be covered with old tin or galvanized iron so that the water cannot soak through the top of the box. The rollers are made of old 1¼-inch pipe and 1-inch bolts or rods so that when expansion occurs the pipes will be free to roll.

In case the soil is very wet, a 3- or 4-inch field tile should be laid about 3 inches under the box to drain the water away. If several hundred feet of pipe are laid in a direct line in the box and a leak occurs the pipe can be disconnected at both ends and then easily drawn out and repaired, a rope should be secured to the one end so when the pipe is repaired it can easily be drawn back in place again. In this case the cost of digging and searching for the leak, and the time lost in replacing the dirt can be saved, which is quite an item.

W. H. WOLFGANG.

Toledo, O.



BOXING FOR UNDERGROUND STEAM PIPES

Reliability of Test Figures

The editorial in the February 7 number under the above title is quite true. I firmly believe that one of the greatest hindrances to engineering progress today is the overconfidence which the average man has in his own work and the readings and results obtained by himself.

Erroneous results of gas analysis made with the Orsat apparatus have undoubtedly occurred hundreds of times. In the majority of cases the operator is not as inquisitive as the one referred to was, and fails to learn the cause of the inaccurate results; in fact, many are unable to tell when the results are right and when not.

The trouble described can easily be avoided by having the tubes in the front leg of the pipette supported on a spiral wire so that none of them will drop into the small U-tube connection through which the liquid passes back and forth between the two legs of the pipette.

E. G. BAILEY.

Boston, Mass.

I was interested in the editorial headed "Reliability of Test Figures" in the issue of February 7, especially that part

relating to the Orsat apparatus, as we had the same trouble recently in analyzing producer gas. In all previous tests we had obtained only a trace of oxygen, generally none. All at once we began to get anywhere from 4 to 11 per cent. The action described in the editorial was all there. We thought that the new reagent was at fault and emptied it out of the oxygen pipette at which time we found that one of the little glass tubes had slipped down into the neck of the pipette. We got all of the tubes up into the body of the pipette, put the reagent back, made ar analysis and the percentages ran about as they should.

J. O. BENEFIEL.

Anderson, Ind.

Capacity of Refrigerating Plant

The article under the above in the February 21 issue contains errors.

The total heat transmission,

$3.43 \times 484 \times 55 = 91{,}307$ *B.t.u.*, *not* 91,770.

After having ascertained the number of B.t.u. to be abstracted it is useless, and not customary, to convert this quantity into "pounds" (ice-melting effect), because in dividing B.t.u. by 288,000 the capacity of the compressor in tons refrigeration per 24 hours is obtained directly. For 12 hours' run simply use 144,000 as the divisor.

The temperature of ammonia evaporating under a back pressure of 27 pounds gage is 14 degrees Fahrenheit. As the room temperature is to be 35 degrees, the difference will average 21 degrees. A lineal foot of 1¼-inch direct-expansion pipe will abstract between 9.6 and 13.7, say on the average 12, B.t.u. per 12 hours for each degree difference; hence, in our case 252 B.t.u. For 12 hours' run we, therefore, require only

$91{,}770 \div 252 = 364$ *lineal feet of pipe*,

not 3500 or 4000 feet as was given. With 3500 feet of piping properly distributed there would be absolutely no storage space left in the size of refrigerator under consideration.

To operate for only 6 hours continuously is bad practice, because of the incidental fluctuating temperatures which are injurious to the goods stored, their temperature having to be reduced to below 35 degrees in order to counteract excessive temperature rise during the 18-hour period of shutdown. The proper way then is to use brine-storage tanks which continue to refrigerate after the machine is stopped. When, however, expansion pipes only are employed, the machine should be run mornings and evenings. With but 6 hours' continuous operation, provided the goods can be cooled down in so short a time, we require not only twice the amount of piping needed with 12 hours' run but rather more, say 800 feet (as against 6400 feet) because toward the end the temperature difference will be small. Rather than crowd in the 800 feet of pipe, the machine should be proportioned to do its work with ammonia gas at some temperature lower than 14 degrees.

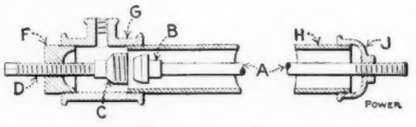
One receives the impression from the article that for 6 hours' run *less* than double the amount of piping needed for 12 hours is sufficient, while, as shown above, *more* than the double amount is required, at the same back pressure.

CHARLES H. HERTER.

New York City.

Homemade Trap

I saw in the January 31 issue of POWER a description of a homemade steam trap, by George J. Little. I have had a good deal of experience with traps of the same general type, and find that they give excellent service. They can be so constructed that there is practically no loss of steam. The outlets from all of our traps of this kind are exposed; in operation there is a flow of water, then a barely perceptible puff of steam which instantly stops. Good satisfaction may be secured by making the brass pipe from 18 to 24 inches long. This allows a sufficient movement for satisfactory operation.



A HOMEMADE TRAP

The construction of the traps which we make is shown in the accompanying figure. The pipe *A* is of brass, the size depending on the amount of water to be handled. This pipe is threaded on both ends. One end screws into the half *B* of a ground brass union, the other into the reducing coupling *J*. Enough thread is cut on this end to allow for a connection to the system to be drained. The coupling, in turn, goes onto the piece of iron pipe *H* which is large enough to contain the two parts of the union. On the other end of the iron pipe is a tee *G*, with its side outlet connected to the discharge for the water. Screwed into this tee is a reducing bushing *F*, through which passes the solid rod *D*, with a squared outer end, connected to the other half *C* of the union. This rod affords a very easy method of adjusting the relative positions of the two parts of the union.

The advantages of this trap are its uniform reliability, ease of adjustment to prevent loss of steam, and the simplicity of its construction.

J. F. MOWAT.

Joliet, Ill.

Vacuum for Reciprocating Engines

I cannot but feel a little sorry for the young engineer who learned some facts about steam distribution in engines and then lost confidence in his knowledge when confronted with the arguments of John H. Ryan, as presented in POWER for January 31. It seems hardly possible that the young man was considering the change of the low-pressure cylinder to permit of expansion clear down to 28 inches vacuum—producing a sharp point on the indicator diagram. The 36-inch low-pressure cylinder of the engine (an 18 and 36 by 48) would probably be operated with a terminal pressure of from seven to ten pounds absolute, according to load. An improvement in the vacuum would not imply an increase in cylinder dimensions, but only a little greater drop at the end of the diagram.

I am ready to credit the young man's next statement, that a well designed new engine in the same town was being operated with 28 inches of vacuum. His instructor's bet—that indicator diagrams from that engine would show the exhaust valves opening early in the stroke, with the cylinder pressure falling to the exhaust back pressure (28 inches of vacuum) by the end of the stroke—was safe. What well designed engine would be operated otherwise than with the exhaust valves opening early enough so that the forward-pressure line would fall to the back-pressure line at the end of the stroke, or very shortly after? A later opening of the exhaust valves would cause what every engineer knows as a "toe" on the end of the diagram.

The fact is, the young student was right in principle, but perhaps failed to make sufficient drawback allowances when estimating the saving to be realized by the proposed condenser improvements. He was right in believing that a pound pressure removed from the front of the piston is equal to a pound applied to the back. He was also right in suggesting a larger air pump for a higher vacuum as a means of increasing the economy of the plant. The larger pump would have to handle twice the quantity of entrained air and noncondensable gases, not twice the volume of vapor or steam, when the vacuum increases from 26 to 28 inches, and the volume of the air would, of course, be much less than the total volume of the vapor exhausted from the engine into the condenser, therefore, much less than 60 additional cubic feet volume per pound of steam, upon increasing the vacuum from 26 to 28 inches. Air-pump operation costs the same, whether the steam comes from cylinders or turbines; why use 28 inches vacuum on a turbine, if the cost to produce the higher vacuum is as much as the gain?

In regard to cylinder cooling and the consequent initial condensation, the ter-

minal pressure due to the expansion of the steam in the cylinder has more effect than has any subsequent terminal "drop" or free expansion of the exhaust into the condenser. If the compound engine of this argument were operating with a mean effective pressure, referred to the low-pressure cylinder, of 40 pounds, the removal of 2 pounds back pressure, by increasing the vacuum from 24 to 28 inches, would make it necessary to cut off enough earlier to reduce the average forward pressure by 2 pounds in order to keep the same area in the indicator diagram. This indicates, roughly, a saving of 2/40 or 1/20 of the steam, against which there would be some increased losses, so that the full 5 per cent. saving would not be realized; but as large compound engines often operate on lower mean effective pressure than 40 pounds, I am not convinced that the ambitious young engineer was all wrong in expecting to save enough coal to justify a better vacuum than 24 inches.

S. H. BUNNELL.

New York City.

It looks to me, after reading J. H. Ryan's article in the January 31 issue, that he tried hard to throw dust in the young refrigerating engineer's eyes concerning this low-vacuum theory for reciprocating engines. I believe that the young fellow knew better but had not the argumentative tact necessary to pin Mr. Ryan.

Of course, I do not believe that 28 inches of vacuum makes for economy in this size of engine, but neither do I believe it would prove economical were the cylinder twice as large. What has the size of the low-pressure cylinder to do with the degree of vacuum attainable or maintainable by the condenser? I always thought that consideration of the power required to drive the air pump and the amount of heat to be supplied to the feed water by the primary heater determined the economical degree of vacuum, provided there was sufficient cooling water to be had. During my experience with a number of compound engines of different cylinder ratios, I never yet was able to take a diagram where the low-pressure steam expanded to the temperature of the vacuum, before the exhaust valve opened. Therefore, did Mr. Ryan expect to overawe the engineer by all that talk about the expansion laws of gases, and did he think the young fellow swallowed such statements that he would require a 60-inch low-pressure cylinder and 500 degrees of superheat to obtain 28 inches of vacuum? What did all those engineers who operate a compound engine, having a low-pressure cylinder of 36x48 inches think on reading the statement that 21 inches of vacuum is all they should carry if they would run their engine to the best advantage?

In one paragraph Mr. Ryan allows something sensible when he states, "I admit that anyone could get 28 or more inches of vacuum if he had water enough." That is just what the young engineer was after, the very thing that Mr. Ryan was called to settle—the question of obtaining more and cooler water. It seems to me that he should proceed to show (if it were true) how the interest on the initial expense would offset in dollars and cents whatever gain resulted from an increase of the vacuum. Instead of that, however, he wants to wager that the exhaust valves of the cotton-mill engine open for release before the piston reaches the end of the stroke. Of course, the young engineer did not take him up. Would you?

Further on he states, "There would probably be more than six pounds absolute pressure in the low-pressure cylinder when the exhaust valve opened and all this heat would be rejected into the condenser," when 28 inches of vacuum was carried on the cotton-mill engine. Now, would there be any less heat rejected if 21 inches was the rate of vacuum carried? Is it common sense to assume that the higher the vacuum the higher the terminal pressure? Toward the end of the article he states, "Reciprocating engines running with complete expansion to a high vacuum do not show as good results (as turbines) because the loss from the cylinder condensation is high," meaning thereby, from what can be gleaned from preceding paragraphs, that most of the condensation takes place in the low-pressure cylinder if a fair vacuum is maintained. Now, taking Mr. Ryan's example of 15 pounds receiver pressure, I would like to ask in which cylinder is the greater condensation in the following case: The high, assuming the common absolute pressure of 165 pounds, and a back pressure of 30 pounds; or the low, which expands this 30 pounds absolute pressure to an absolute back pressure of 2 pounds? It is commonly asserted, and generally believed, that cylinder condensation is due to the difference in temperatures between the initial and the exhaust steam in each cylinder. Presuming this to be correct, Mr. Ryan, when considering the question, may neglect the fact, that usually, due to a "drop" in the receiver, the initial steam of the low-pressure cylinder is dryer than that of the high-pressure cylinder.

C. HUGHES.

Saxonville, Mass.

Engineer or Laborer

The editorial under the above caption in the January 31 issue is one of the best I have ever read. The employment of such men as the quoted advertisement would undoubtedly bring out, probably is responsible for more waste and accidents than any other single cause. I remember one plant in which low-grade men were employed on the night shifts; there always was enough repair work to keep one or two men busy all the time.

Besides the man who does not know, the man who "boozes" is one of the most dangerous that can be employed in a plant. I remember a case where three high-speed engines were put out of commission on account of a night engineer who would "booze." The next day was a busy one for all hands, getting those engines into shape again. This man had been in the habit of "hitting it up" and then depending upon an assistant to carry him through. Because he ill treated his assistant the man stayed in the boiler room at his post and away went the engines. After that the management hired a higher-priced and more reliable man.

C. R. MCGAHEY.

Baltimore, Md.

Plant or Unit Efficiency

One is frequently startled by the news that someone is producing a kilowatt-hour on something like 2.25 pounds of coal. Hence, it was with much pleasure that I read the editorial under the above caption in the February 7 issue.

My idea of the way in which to get the coal consumption per kilowatt-hour is to divide the pounds of coal consumed each month by the electrical output minus the quantity of current used by the electrical auxiliaries.

For instance, if there are 5000 tons (2000 pounds per ton) of coal in the bunkers at the first of the month and 15,000 tons are received during the month and if 4000 tons are left over at the end of the month, it is evident that 16,000 tons, or 32,000,000 pounds, of coal have been consumed.

Now, if the output of all of the generators is 9,000,000 kilowatt-hours and the consumption for station lighting and for driving the electrical auxiliaries, such as motor-driven wet pumps, motor-driven circulating pumps and motor-driven exciters, is 1,000,000 kilowatt-hours, the net output to the line is, evidently, 8,000,000 kilowatt-hours, and the coal consumption, four pounds per kilowatt-hour.

Now, to figure in another way; suppose that two 5000-kilowatt machines make a kilowatt-hour on 15 pounds of steam, that another uses 16 pounds and that four engine-driven 3500-kilowatt units use 17 pounds. With an evaporation of seven pounds of water per pound of coal, in the case of the machines consuming 15 pounds of steam it is the idea of some that a kilowatt-hour is being generated on 2.14 pounds of coal, and so on down the line.

Although it may seem paradoxical, sometimes the machine making a kilowatt-hour on 16 pounds of steam is using more coal than the one requiring 17 pounds. If the machine with the lower rate is a turbine, it evidently would

use nearly twice as much circulating water as the reciprocating engine and, hence, considerably more power for condensing purposes. Also, as it is essential that a high vacuum be maintained for the turbine, the condenser temperature is usually as close as possible to 70 degrees. On the other hand, with the reciprocating unit no undue alarm is caused if the condenser temperature is as high as 95 degrees. Roughly, this means 25 B.t.u. per pound to the good when it comes to making a pound of steam from the condensate.

Although I have transposed a few of the sizes in the foregoing, the averages and rates are the same as those obtained in a plant with which I was connected. It may be interesting to learn how closely the monthly overall plant results compare with individual test results.

Suppose that two 5000-kilowatt machines put out 4,500,000 kilowatt-hours per month at the rate of 15 pounds of steam per kilowatt-hour. This, based on seven pounds evaporation per pound of coal, would seem to require 4815 tons of coal.

Let the 5000-kilowatt machine with a 16-pound rate put out 2,700,000 kilowatt-hours. This would indicate the consumption of 3037 tons of coal. Then, consider that the four units with a 17-pound rate have a total monthly output of 4,000,000 kilowatt-hours. These would apparently require, then, 4840 tons of coal and the total for all of the machines would appear to be 12,692 tons. As a matter of fact, in a plant containing machines of these sizes the coal consumed per month would amount to very nearly 20,000 tons.

If the current used by the auxiliaries equaled 200,000 kilowatt-hours, the actual coal consumed would amount to 3.63 pounds per kilowatt-hour delivered to the line.

One naturally asks what causes such a large discrepancy. Besides the steam-driven auxiliaries there are the peak loads, and peak loads are not money makers by a long shot.

In a plant of the size under discussion there would be needed about 40 boilers of 600 horsepower capacity each. The maximum load would have to be carried on about 38 boilers, two necessarily being down for cleaning. The peak would probably amount to about 33,000 kilowatts. The smallest load would probably be 4000 kilowatts and the morning load would run about 8000 kilowatts less than the evening load. The load during the middle of the day would probably average about 17,000 kilowatts. At the usual rating of 700 kilowatts per boiler, there would be required 33 or 34 boilers in the morning and about 24 during the day. Thus, some of the boilers are banked twice each 24 hours and this necessarily entails quite a loss.

To sum up, the editorial states that unit tests are more common than plant tests. This is true to a certain extent, but if every engineer keeps a monthly report, as he should do, he has virtually a plant test each month and it is the only true test, for the fact remains that the only true way to figure plant economy is to find out what it will do month after month and not during few hours of frenzied effort to lower the world's record for steam consumption. A plant is not run under those conditions day after day. If the right sort of a record is kept, one can tell at the end of each month wherein the efficiency has dropped, whether it be waste, oil, machine supplies, low feed temperature or any other item used day after day.

L. H. EDWARDS.

Kittanning, Penn.

Compound Engine Proportions

Referring to Mr. Cassidy's criticism in the January 31 issue of my article on "Compound Engine Proportions," which appeared in the issue of November 29 last, the first point of misunderstanding is due to a typographical error. Where an engine operates against back pressure, the mean effective pressure, of course, will be reduced and not increased.

Relative to the next point, which pertains to terminal pressure, this may be made somewhat clearer as follows:

Assuming that an engine is cutting off at one-quarter stroke in the high-pressure cylinder with a 4-to-1 ratio, the number of expansions will then be 16, neglecting cylinder clearance. Now, the terminal pressure obtained in the low-pressure cylinder is dependent upon this ratio of expansion and the initial pressure in the high-pressure cylinder; that is, with 16 expansions and a known steam pressure a certain terminal pressure will result; thus it is a comparatively easy matter to calculate, at least approximately. If, now, with this same engine the size of the high-pressure cylinder is reduced, the cylinder ratio is increased. If the number of expansions or the steam pressure is not changed, there will be no change in the terminal pressure. By changing the high-pressure cylinder only the cylinder ratio and the point of cutoff in the high-pressure cylinder are changed.

In connection with the example worked out in the article of an engine having a 5-to-1 ratio and a cutoff of 0.275, it is true that in the case of an engine proportioned with a high cylinder ratio there is some drop in pressure at the end of expansion in the high-pressure cylinder, or, in other words, there is expansion through the receiver as Mr. Cassidy points out. But, tests show without question that up to a certain point, high-cylinder ratio is conducive to economy; that is, the benefit obtained by additional expansion secured by increased cylinder ratio more than offsets any loss due to expansion through the receiver. Some may say that the drop at the end of expansion in the high-pressure cylinder can be reduced by shortening the low-pressure cutoff, but when this is done the condensation in the low-pressure cylinder is increased and matters are not helped. It is, therefore, found in the case of an engine designed with a high cylinder ratio that it is best to divide the load about equally between the two cylinders; when this is done some drop will be obtained at the end of expansion in the high-pressure cylinder.

Relative to the next point: With an engine with cylinders 20 and 40 inches in diameter, cutting off at 0.2 of the stroke in the high-pressure cylinder, I would say that in the case of the average engine working, say, with 150 pounds steam pressure, condensing, it would improve the economy slightly to reduce the high-pressure cylinder to 18 inches in diameter. Theoretically, of course, there should be no change in economy since no change has been made in the steam pressure or the number of expansions, but when the engine is cutting off at only 0.2 of the stroke there is excessive cylinder condensation because this cutoff is somewhat earlier than is best for producing the most economical results. Therefore, the condensation losses would be reduced by reducing the diameter of the high-pressure cylinder.

I would like to add that in the article under discussion it was not my intention to give the student of engineering a complete treatise on compound engines and the rules for proportioning them, but to bring out certain points which it has been found are not always understood by engineers. The article and the diagrams were rather intended for those who have had some experience in designing engines—the diagrams having been found useful in making determinations of cutoffs, cylinder ratios and mean effective pressures rapidly without any calculations whatsoever. The results given in the diagrams have been checked up with a large number of indicator diagrams taken from a variety of engines and found to be very close to the results actually secured.

ALWIN HOFMANN.

New York City.

Consul Albert Halstead, of Birmingham, learns that there are now 80 plants in the United Kingdom for the conversion of garbage of cities into electric power, and that they are increasing at the rate of 20 a year. An English mechanical engineer calculates that there is a long ton of refuse for every 1000 inhabitants, equal to about 300 pounds of steam per hour for nine hours per day, if destroyed in the properly designed destructor.

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POWER

Mayor Gaynor's Attitude'—?

Last May, the New York Engineers' Protective Society, said to be the oldest engineers' organization in New York, addressed a set of resolutions to Mayor Gaynor calling for an investigation into the shutting down of several city plants and the substitution of central-station service. Although nine months have elapsed, there have been no visible signs of activity in the matter emanating from the city hall, nor has the communication been acknowledged. We do not believe the mayor has wilfully sidetracked the resolutions but rather are of the opinion that, in the rush of official business, their importance has been overlooked; or perhaps they have been relegated to the care of some subordinate who lacks both the interest and the authority to take action.

However, the Bureau of Municipal Research, a private organization devoted to investigating and remedying the abuses and mismanagement of city affairs, has gone into the subject very carefully and is about to make a report upon its findings. It would seem to be good form, at least, for the mayor to officially recognize the agitation now being carried on and to show that he has an interest in a subject so important to the city's welfare.

Scientific Management in Education

Just now, popular interest and the space in the ten-cent magazines is about evenly divided between aviation and scientific management. Both are useful and interesting, but perhaps slightly overdone at present.

Scientific management, as first developed by Mr. Taylor and Mr. Gantt and afterward by Messrs. Emerson, Day, Cooke and others, has undoubtedly come to stay and will find wider fields of usefulness as time goes on. It is not a universal panacea and will not cure all evils or suit all conditions.

One of the most interesting applications of the principles involved has recently appeared in a bulletin published by the Carnegie Foundation for the Advancement of Teaching, written by Morris L. Cooke, of Philadelphia.

As stated by President Pritchett in the preface to the report, Mr. Cooke was chosen to conduct this investigation as an outside expert, not an educator, who would view the conditions from the standpoint of a business man.

Both President Pritchett and Mr. Cooke appreciate the fact that there is much in college work which cannot come under the ordinary rules of business, much less under the strict rules of modern management.

It was certainly rather a bold experiment to apply business standards to the more or less psychological problems of the college and university. Some still bolder spirit may next apply the same standards to the work of an episcopal diocese or a presbyterian synod.

Considering the inherent difficulties of the experiment, it would seem that Mr. Cooke has done pretty well. For the most part, he has confined himself to the material side of college work, such as the purchase of supplies, the care of grounds and buildings and the use of rooms and apparatus, and here he is on safe ground.

When he steps over the line into the field of research, of instruction and of educational efficiency, he treads rather gingerly and occasionally breaks through. The use of the student hour is not original with him, since it has been used many years as a unit of comparison. It is not and never can be a gage of efficiency. Let us suppose, for example, that a teacher has a class of twenty students for five hours a week, making one hundred student-hours.

Let us further suppose that the exigencies of the time require an increase of the number of men in a section to thirty. According to business standards, the instructor is turning out fifty per cent. more product per week for the same cost in dollars, and is therefore that much more efficient. From an educational standpoint, he is probably less efficient than before.

The employment of functional superintendents for the material or concrete things of the college is desirable, but that a business manager should have anything to do with the administration of the teaching or the control of examinations is extremely undesirable. The efficiency of one man's teaching or the inefficiency of another man's teaching can no more be measured by hours or by dollars than the preaching of a clergyman or the work of a statesman.

On the whole, Mr. Cooke's report is instructive and interesting and is destined

to have a decided influence in the administration of colleges and universities. He should be met and welcomed in the same spirit in which he writes. Such sarcastic and ill-tempered comment as comes from some educators is childish and out of place.

As long as educational institutions look to the taxpayers and to private benevolence for support, they are open to the inspection and criticism of the layman. The methods employed in educating the youth of the land are of interest to all, outside as well as in, and are no more exempt from investigation than other public utilities. Publicity is wholesome for colleges as for municipalities or corporations, and the surest way to meet and to disarm unfavorable criticism is to throw all debatable subjects open to frank and free discussion.

Our educational institutions, like our religious ones, cannot afford to take an attitude of superiority to the rest of mankind but must be prepared to defend themselves against any accusations of neglect or inefficiency.

Neglecting Opportunities

A certain class of engineers are seemingly imbued with the idea that if a piece of apparatus will operate something after the manner intended, there is no necessity of giving it further attention.

Getting after a repair job "as soon as there is time" is what some engineers say that they are going to do, but they directly proceed to waste more time than would have been necessary to put the defective apparatus into proper condition.

"I am going to fix it next Sunday when the plant is shut down" is what another says. "Then I can take all the time necessary and do a good job." But he does nothing of the kind.

"It is working, so what is the use of meddling with it and perhaps make matters worse," says another.

But the makers of such statements know that they are offered merely as excuses for failing to do duties that should be performed.

Any piece of apparatus that requires repairs should be attended to at once. Never mind whether it is convenient and agreeable or not. The main thing is to eliminate the defect so that the device will operate as it was intended to, when built.

How "penny wise and pound foolish" for an engineer to allow two or more tubes to leak in the rear head of a boiler, when they could be made tight in a short time with the boiler cold and the water run out.

How wasteful for an engineer to allow the valves of an engine to continue to operate when improperly adjusted, just because he thinks he does not have time to attend to them. Many times one is led to believe that failure to adjust valves properly is due to a lack of knowledge of how to do the work, rather than because of lack of time.

Putting sundry repair jobs off until Sunday is bad practice, not only because a man gets into the habit of putting off things, but because it makes him spend a day doing the same kind of work seven days a week when he should spend one of these days in an altogether different manner. A day of leisure, devoid of the nerve-racking occurrences of the daily grind prepares a man for better service on Monday morning, and more efficient work throughout the week.

Nothing can be good enough unless it is the best. Engineers make a great mistake when they neglect to improve the operating condition of their plants. Because so many have taken the ground that conditions are good enough, the central station has expanded. Its solicitors have been able to show the isolated-plant owner that his operating conditions are not as good as they should be. A contract is signed by the owner and the central station has supplanted a man and his job just because he did not cut down expenses and put the plant on a sound operating basis.

Conditions Have Changed

In this age of progress nothing stands still. Men are constantly gaining experience and the march of progress is astonishing because of the rapidity and masterful manner in which the problems to be solved have been met.

Steam-power plants have received their quota of attention from the inventor and mechanical engineer and the improvement in power-plant equipment has been so great that the engineer has been obliged to advance in both mental and mechanical training.

When stepping into a modern power plant it is hard to realize that only a few years ago the direct-coupled unit was the exception. It would be difficult to imagine a belt-driven generator of the capacity found direct connected and in general use today.

Power-plant centralization has been largely furthered by the improvement in power-plant machinery, and engineers operating the small plant have spent uncomfortable hours wondering what will be the ultimate end. Small steam plants are facing a serious proposition and the men operating them must fight every moment of the day for their very existence.

But this fight is beneficial to the engineer. He knows now that it is possible to succeed only by applying his energies to solving problems that formerly were not considered of importance or necessary for him to know in order to make a success of his work.

What is the result? Just this, the men who have improved their opportunities and fitted themselves for assuming more responsible positions than they formerly held are today operating the large power plants.

What has been done will be done again and the engineer running in the small plant today may be the man selected to operate the large plant of tomorrow. The demand for engineers in large power plants is steadily increasing and the opportunities for rising to better positions will be as frequent in the future as they have been in the past.

Wise engineers will make ready for stepping into the larger plants. There may not be much glory or financial gain at first, during the preparatory stage, but higher wages will come to the man who has improved his opportunity and is standing at the line ready to lead when the starting gun is fired.

Congress recently passed a bill appropriating thirty-six thousand dollars for the installation of a refrigerating system in the Capitol. It is to be used for furnishing cool air to the House of Representatives and the various committee rooms. Judging from the debates that have been going on recently between the members of that body, the installation of a refrigerating system is timely.

How much water are you evaporating per square foot of surface per hour? How much over their rated capacity are you running your boilers? What draft do you use? What are the conditions of impingement of flame on spots of the tube surface, and what are the conditions of cleanliness of the tubes? We should like to have the subject discussed in the light of actual experience.

Is not the recent increase in boiler-tube troubles due more to increased work than to increased pressure, or poorer material? A tube is more than twice as liable to suffer when it is evaporating six pounds of water per square foot as when evaporating three.

The verdict of the coroner's jury which inquired into the cause of the recent dynamite explosion in Jersey City, to the effect that it had been caused by a lighted match or cigarette dropped by some careless individual, is in the same class as some boiler-explosion verdicts.

We believe there was an international exposition once which was substantially ready at the date of opening, and it was a success—San Francisco papers please copy.

And now Rhode Island is after a law providing for the licensing of engineers and the inspection of boilers. There is, as usual, a bill before the New Jersey legislature, several in fact.

Lap-seam boilers are unsuitable for some classes of work; likewise lap-seam engineers. Neither should ever be employed where the real thing is needed.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Replacing Mud Drum Nipples

If it were necessary to change nipples on a Babcock & Wilcox boiler, how should I go to work to replace them; the ones to be taken out are a foot away from the handholes in the mud drum, and what tools would be used?

C. N. T.

Use a bent diamond chisel to open the nipple, working through the handhole in the header. Then, with a blunt tool, drive in the side of the nipple between the header and mud drum, letting it drop into the drum. Hold the new nipple in place with wire and a wedge. Flare upper end slightly then expand it, being careful to see that each end projects ¼ inch beyond the tube hole. Change expander and expand lower end. After expanding the lower end, drop the expander to clear tube hole and expand slightly to flare the lower end. Use a Babcock & Wilcox special expander.

Pressure on Projected Area

If the cylinder of an engine is 50 inches in diameter with 110 pounds pressure and 45 pounds receiver pressure, and if the crank pin is 12 inches in diameter and 14 inches long, what will the load be on the projected area of the pin?

P. O. P.

The total pressure on the piston is the product of the piston area multiplied by the difference in the pressure on its opposite sides. This divided by the projected area of the pin is the pressure per square inch. In this instance it is

$$\frac{1963.5 \times (110 - 45)}{12 \times 14} = 759.62 \text{ pounds}$$

Gravity and Vacuum Heating Systems

What are the essential points of difference between a gravity and a vacuum heating system?

G. H. S.

In a gravity system the condensation is returned to the boiler or led to a receiving tank by gravity. In a vacuum system the flow of steam is kept up by means of a pump or ejector connected to the radiators by which a partial vacuum is maintained in the system.

Change of Cutoff and Compression

How may cutoff and compression be changed in a simple slide-valve engine?

C. V. C.

Increase of outside lap shortens the cutoff. Increase of inside lap increases the compression and decrease of inside and outside lap lengthens the cutoff and decreases the compression.

Width of Belt

What should be the width of a double leather belt to transmit 500 horsepower, running on a 22-foot flywheel making 76 revolutions per minute?

J. A. L.

The rim speed of the wheel is 5250 feet per minute. Allowing 50 square feet of belt surface per minute for each horsepower, 25,000 square feet of belt will have to pass over the pulley each minute to transmit 500 horsepower, and the width will be

$$\frac{25{,}000}{5250} = 4.72 \text{ feet}$$

Real and Apparent Clearance

What is the difference between the actual and apparent clearance in an air compressor?

A. R. C.

The apparent clearance is the space not swept through by the piston. The actual clearance is the space filled by the air compressed in the apparent clearance space after being expanded to the suction pressure. It shows on the indicator diagram at the point where the expansion line meets the intake-pressure line.

Power to Operate Elevator

Does it require the same power to operate a hydraulic elevator whether light or loaded?

O. E. P.

It is the same in both cases as it takes the same quantity of water to fill the cylinder, and the water, whether from an accumulator or pressure tank, is under the same pressure.

Rewound Electric Motor

Suppose an electric motor rated at ¾ horsepower running at 1200 revolutions per minute had its armature rewound to run at 600 revolutions per minute, would it then be able to withstand the throwing in of the switch without injury, and would its rating be ⅜ horsepower?

R. E. M.

If the work is properly done, yes.

Heat and Pressure Stresses

Which causes the greater stress in the sheets of a return-tubular boiler, heat or pressure?

H. P. S.

Heat, when it causes unequal expansion.

Equivalent Evaporation

If one pound of coal will evaporate ten pounds of water from and at 212 degrees, how many pounds will it evaporate from feed water at 80 degrees into steam at 100 pounds pressure?

F. O. E.

Water at 212 degrees contains 180 heat units above 32 degrees and steam at the same temperature 1150.4. It therefore requires 9704 heat units to change ten pounds of water at 212 degrees into steam at the same temperature. Water at 80 degrees contains 48.3 heat units per pound. Steam at 100 pounds gage pressure contains 1188.8, and it therefore takes

$$10\ (1188.8 - 48.3) = 11{,}405 \text{ heat units}$$

to change ten pounds of water at 80 degrees into steam at 338 degrees; and one pound of coal which will evaporate ten pounds of water from and at 212 degrees will evaporate

$$\frac{9704}{11{,}405} = 0.858$$

or 85.8 per cent. of ten pounds from water at 80 degrees into steam at 100 pounds gage pressure.

Patch on Boiler Sheet

In patching a boiler, should the patch be put on the inside or outside of the shell?

P. B. S.

It should be put on the inside, as otherwise it forms a pocket for the collection of sediment.

Hight and Capacity of Chimney

What is the relation of the hight of a chimney to its capacity?

H. C. C.

The capacity of a chimney varies as the square root of its hight. To double the capacity of a chimney its hight would have to be increased four times.

Boiler Explosion at Verona, Penn.

By Edward T. Binns

At about 4 p.m. on Monday, February 26, a vertical boiler, 36 inches in diameter by 6 feet high, exploded at the Ideal steam laundry in the town of Verona, Penn. A number of fatalities were narrowly averted. Two men were badly hurt; one of them, the engineer, in all probability will not recover. The boiler, which weighed about 1600 pounds, was shot vertically into the air about 300 feet, turning over several times and landing on top of a three-story building about two blocks away. It crashed through the roof, the third and second floors, and came to rest in the middle of a clothing store on the ground floor. As near as can be learned, the engineer, who was a new man and who came to the plant from the police force, had been doing some work in the main building and had just gone to the engine room to prepare for shutting down. On his way to the hospital he stated briefly that he had barely commenced these preparations when the explosion took place.

An examination of the ruptured plates plainly indicated that they had been red hot, the edges of the torn sections being curled and quite blue.

The firebox was 36 inches high and 30 inches in diameter, with a 9-inch flue leading to the smokestack. The feed water was delivered into the water leg. The city water pressure in Verona is about 150 pounds to the square inch, so that no pump or injector was needed to force water into the boiler, and in this case no heater was used.

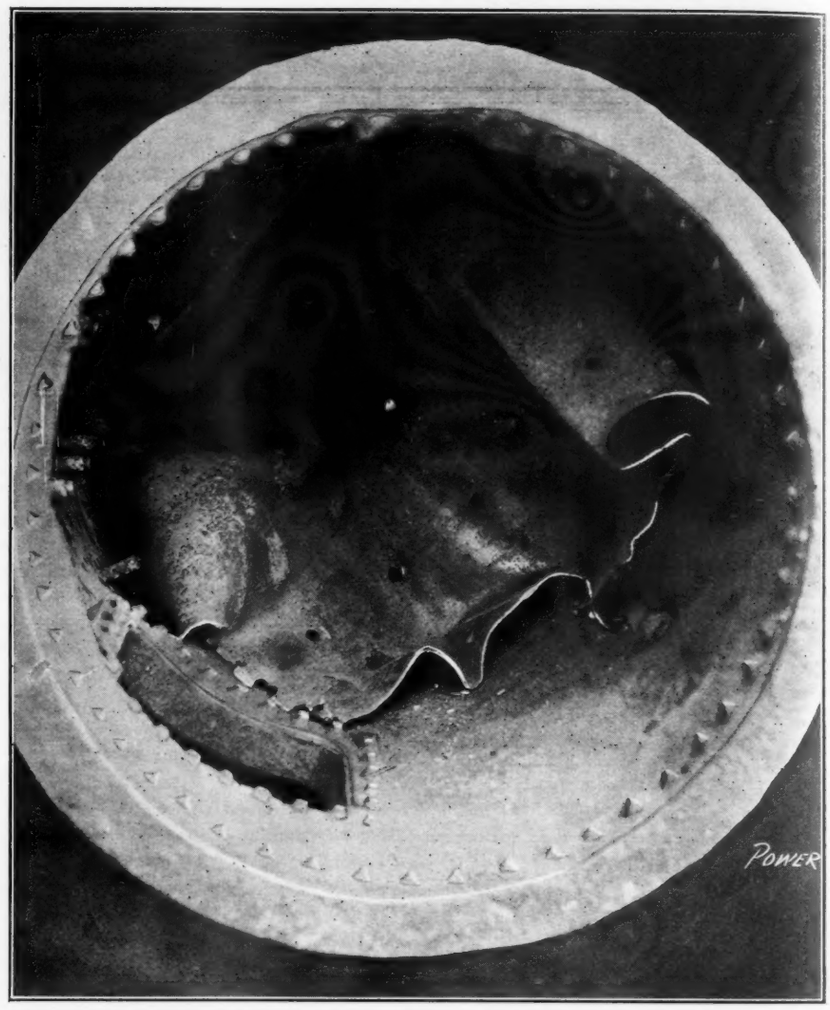


Fig. 3. Interior of Firebox After Explosion

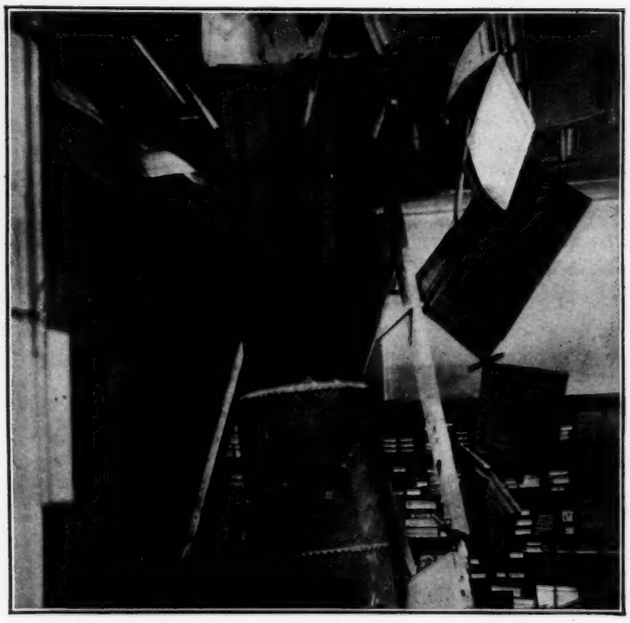


Fig. 1. The Boiler in the Clothing Store

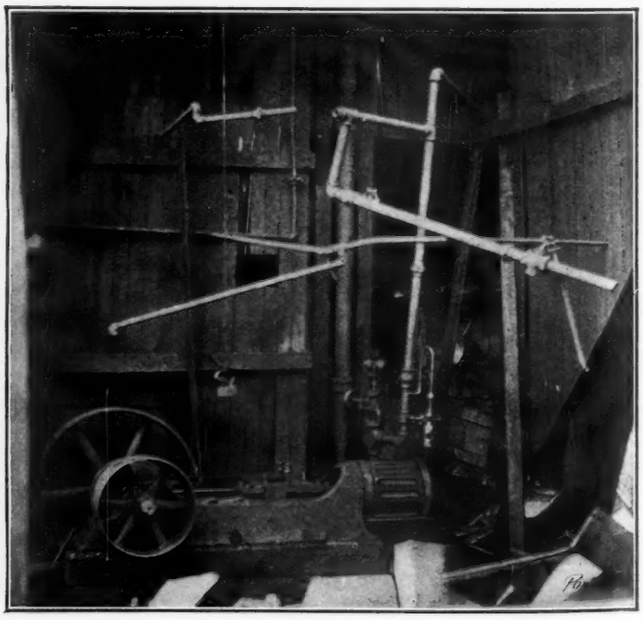


Fig. 2. Damage to Engine Room

The boiler was only about three years old. About seven months ago it was inspected by the county boiler inspector who gave it a thorough hammer test. Also, at the owner's request, he gave it a hydrostatic test of 150 pounds. One hundred pounds steam pressure was allowed but the safety valve was set to blow at 80 pounds.

Some repairs to the steam gage, water column and safety valve had been ordered and made before the explosion.

The firebox, which was of 3/16-inch plate, was badly torn. The rupture commenced at one edge of the firing door and followed an irregular course for three-quarters of the way around. The tear was practically along the zone of the fire. The plate pulled loose from twenty-nine ¾-inch, solid staybolts which were screwed into it, and doubled up against the crown sheet.

There is as yet no State engineers' license law in Pennsylvania, though a bill is now pending in the legislature.

The Industrial Safety Association

On Friday evening, March 1, D. T. Williams entertained at dinner at the Engineers Club, New York, a number of editors of technical and industrial papers for the purpose of acquainting them with the objects and activities of the Industrial Safety Association. After the host had effectually disproved his introductory declaration that he could not make a speech by setting forth most impressively the obligation of those in charge of industrial operations and others of the more fortunate class who are in a position so to do to minimize the hardships, dangers and chances for injury which surround the worker, he introduced Dr. F. R. Hutton, president of the new organization.

Doctor Hutton quickly demonstrated to his hearers that the association had a much wider field and loftier mission than the exploitation of mechanical devices for the guarding of life and limb, and impressed them with the economic importance of maintaining the efficiency of the working force of the community by establishing conditions conducive to health, comfort and security from bodily harm. His remarks were illustrated by a series of lantern slides, showing devices and methods employed toward that end.

The company then visited the American Museum of Safety, which is maintained in the Engineering Societies building, 29 West Thirty-ninth street, where many of the devices previously illustrated are upon exhibition, where statistics are available and methods exemplified. The museum is free to the public between the hours of 9 and 5 every day except Sundays and holidays.

Institute of Operating Engineers to Organize Branches

On Friday evening, March 17, at 8:30 there will be a meeting in the lecture room of the Modern Science Club, 125 South Elliot place, Brooklyn, for the purpose of organizing a branch of the Institute of Operating Engineers. Members and all interested are invited to be present.

On Saturday evening, March 18, at eight o'clock, there will be a meeting in the rooms of the Institute of all members and those interested, in New York City and the Bronx. This meeting is called for the purpose of organizing a branch of the Institute in New York City. At this meeting the officers of the branch will be elected, which will include the branch chairman, branch representative to the district council; lecturer on plant operation and chairman of the committee on apprenticeship training; lecturer on educational subjects and chairman of committee on educational subjects; a secretary-treasurer and three councilmen, each for one, two and three years' service. The naming of the branch will also be considered at this meeting and other matters of importance.

As this association will be looked upon as the leader and as all the meetings under the name of the Institute which are held in New York will have to be under its auspices, it is of the utmost importance for all interested to attend this meeting.

Organization of an N. E. L. A. Section at Pittsburg

A banquet to the employees of the Allegheny County Light Company was given by the officers at the Hotel Duquesne, Pittsburg, at 6:30 p.m., Tuesday, February 28. A section of the National Electric Light Association was formed, to be known as the County Light Section, and approximately 150 of the employees joined the section. Prior to this time about 35 of the employees were already Class B members and therefore the section started with 185. H. N. Muller, superintendent of distribution of the Allegheny County Light Company, acted as temporary chairman; W. H. Donkin, general contracting agent of the same company, acted as temporary secretary, and James M. Graves as temporary treasurer.

H. H. Scott, chairman of the membership committee of the National Electric Light Association, gave a history of the organization, told of its growth and the objects for which the association was striving. A. R. Granger, of Chester, Penn., president of the Pennsylvania Electrical Association, followed Mr. Scott and told of the work the company sections were doing, particularly the Philadelphia section.

Erratum

The Heine Safety Boiler Company was organized by Col. E. D. Meier in 1884. Due to a typographical error on page 401 of the March 7 issue the year 1844 was given.

Prime Movers

The speaker for the regular weekly lecture on February 28 at the Modern Science Club, Brooklyn, was George A. Orrok, of the New York Edison Company. His topic was "Prime Movers." He briefly traced the development of the various types of engines from the time of the earliest waterwheels down to the present day.

It was shown that James Watt conceived practically all of the principles that underlie even the present-day reciprocating engine. Much of the increase in economy has been the result of the improvement in the machine tools upon which the manufacture of the engine parts depends.

To illustrate what progress had been made, Mr. Orrok stated that while some of the original pumping engines attained a duty of perhaps 60,000,000 foot-pounds, today a duty of very nearly 200,000,000 foot-pounds has been accomplished.

The lecture was attended by a representative gathering of members and friends.

"Game" to the Core

Frank V. Burlingame, age 36, was seriously injured at the Nickel Plate Railroad's Rocky River pumping plant, on February 24. He was caught by a key projecting from the end of the flywheel shaft and whirled around several times and thrown against the wall of the building. He was badly bruised and both legs were broken in several places. Notwithstanding these injuries he managed to crawl to the throttle when he recovered consciousness and shut down the engine.

Boiler Explosion Kills Four

On March 4, one man and three children were killed and six other persons injured when a boiler at the Blackburn-Gambill distillery on Howard's creek, Breathitt county, exploded. The children were playing about the distillery when the explosion occurred. The other victims were employees.

Flywheel Wrecks Building

On March 3 a portion of the Greensburgh Brush and Wire Factory was destroyed by a flywheel explosion. A defective governor allowed the engine to run away. Several employees were injured.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

Not long ago a great department store in New York City advertised a special sale of men's bath robes.

It was the intention to advertise them at a price of $5.00 each, but through some mistake in the copy the bath robes were advertised in all the morning papers for 50 cents apiece.

With the result that buyers were lined up before the counter three rows deep.

It was too late to do anything except to *stand by the advertising.* The clerks behind the bath-robe counter were instructed to politely explain the mistake, but to refuse no one a bath robe for 50 cents who insisted on having it at that price.

The result was interesting. The majority accepted the explanation and went away with no hard feelings. Some saw the value that lay in the bath robes at the intended price of $5.00, and purchased them at that figure. A few others, perhaps half a dozen, held their ground and refused to pay more than the advertised price—

And got them.

Back of this incident lies the great truth that nowadays *reliable concerns stand back of their advertising at all costs.*

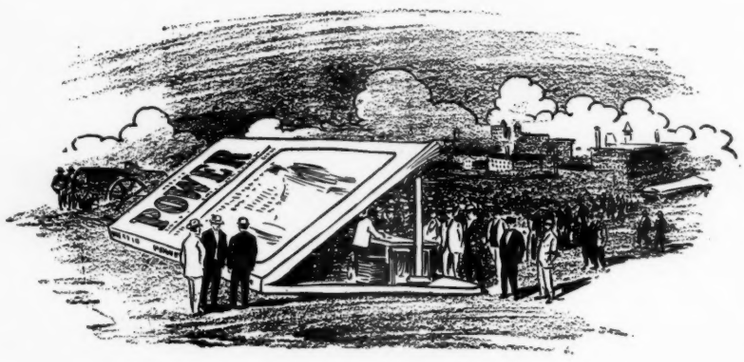
And going into this a little deeper it is easy to see that when a reliable advertiser makes a statement in an ad. it is safe to assume that this concern has carefully sifted over what it has said in order that no misstatements may creep into the copy.

The concerns who advertise in POWER are *reliable* concerns.

They stand back of their advertising.

They claim certain things, secure in the knowledge that they can "make good."

What readers of advertised products need to cultivate more is a *belief* in the *truth* of what they read.



The power-plant man who thrusts aside the honest statement of a reliable concern with an "I don't believe it," isn't doing fair justice to the concern who makes the claim. Neither is he doing justice to himself.

The fact that an advertiser makes a statement which appears to you too big for him to fill does not affect the truth of that statement one way or the other.

Advertisers in POWER are not making claims that they cannot live up to.

They cannot afford it.

Thus, when the manufacturer of a lubricant, for example, tells you what his product will do, consider his word as his honest belief in the efficiency of what he is trying to sell. When the manufacturer of some new power-plant device claims certain advantages, consider his statement seriously and be willing to meet him half-way.

Naturally, the success of many advertised articles often depends upon conditions as they exist in your plant and advertised goods should be carefully studied with due regard to fitting them into existing conditions—

Which signifies that careful comparison and investigation are as necessary as a belief in the word of the advertiser.

The advertisers in POWER are in earnest. Every time they talk to you, through their ads., they put their reputation at stake.

Could they afford to say anything they knew they were unable to back?

Do more than merely *read* the ads.—

Read them with the knowledge that every statement made is an actual fact.

For, truly, the Selling Section is the very last place of all where an advertiser can afford to say anything except what is absolutely true.

Power House Burns

The power house of the Youghiogheny & Ohio Coal Company, at Barton, O., was destroyed by fire on February 20. The loss was $15,000 and necessitated the shutting down of the mine. This is the second fire at this plant in the last year and a half. An incendiary origin is suspected.

SOCIETY NOTES

A meeting of the American Society of Mechanical Engineers will be held in Boston on March 17. A paper by William F. Uhl, "Speed Regulation in Hydroelectric Plants," will be discussed. The Boston section of the American Institute of Electrical Engineers and the Boston Society of Civil Engineers will attend.

On February 24, George A. Orrok delivered an illustrated lecture on "Experiments on the Transmission of Heat through Tubes" to the Engineers Club of Sheffield Scientific School, Yale University. Mr. Orrok referred to the work of the early experimenters, such as Peolet, Grashof, Joule, Nichol and Rankine, also to the later work of Hageman, Ser, Stanton and others, cited his own experiments and gave the mathematics involved.

The next convention of the National Gas and Gasoline Engine Trades Association will be held at the Hotel Pontchartrain, Detroit, Mich., on June 20 to 23 inclusive. The exhibition will be conducted somewhat along the lines of the Cincinnati meeting, and as Detroit contains a large number of factories of especial interest to the gas-engine fraternity, the regular program will include inspection of certain of these plants. The committee on marine engines and the committee on farm power development will both have charge of a portion of the program, which will be along lines somewhat different from any previous meeting.

PERSONAL

F. F. Espenschied, formerly general manager of the Interstate Light and Power Company, of Galena, Ill., has been appointed to the engineering staff of the Hydroelectric Power Commission of Ontario with present headquarters at Preston.

C. S. Roosa, who for many years has been connected with the Liberty Manufacturing Company, has been appointed manager of the New York office of the Elliott Company and the Liberty Manufacturing Company, with offices at 90 West street, New York City. These companies are manufacturers of the well known line of Liberty boiler-tube cleaners and Elliott power accessories.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting in Pittsburg, May 30 to June 2.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York. Next meeting in New York City, May 29 to June 2.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Commander U. T. Holmes, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., O. P. Chamberlain; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill. Meeting first Wednesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., Walter Riddle; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Pres., R. P. Bolton; sec., W. W. Macon, 29 West Thirty-ninth street, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio, September 12-15.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June 5-10, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting at Detroit, Mich., January 15-19, 1912.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May 23-26, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

BUSINESS ITEM

The Phœnix Iron Works Company, Meadville, Penn., announces the appointment of W. M. Bastable as its district sales agent, with offices at 135 William street, New York. This company is the manufacturer of automatic cut-off engines, boilers, feed-water heaters, etc. Mr. Bastable was for a number of years connected with the sales department of the Franklin Boiler Works Company.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS WANTED to solicit for the Rolin patent adjustable grate. Apply Standard Grate Co., Heed Bldg., Philadelphia.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

WANTED—Thoroughly competent turbo-electric power station engineer; must also have thorough operating knowledge of high duty Corliss pumping engines; salary $150 per month. Box 391, POWER.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

AGENTS WANTED—To sell lubricating oils, belts, hose, paint, varnish, to factories, mills, stores, threshers; exclusive territory to right party; experience unnecessary. Manufacturers Oil & Grease Co., Cleveland, O.

DRAFTSMEN WANTED—Power house men experienced in modern steam practice, also electrical men on high tension generating and substations, near Philadelphia; give experience, reference and salary expected. Box 396, POWER.

WANTED—A competent man to do general inspection work for a liability insurance company; must be qualified to assist and instruct other inspectors; expert knowledge of elevators required. Address, stating experience, education, age and whether married or single, Box 399, POWER.

OPERATING ENGINEER for alternating-current central station having steam turbines; steam and boiler experience, preferably turbine required; new station and permanent position; send references. Fulton Light, Heat and Power Co., Fulton, N. Y.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

CHIEF ENGINEER, practical all-around experience, erection, operation, up-keep. Box 393, POWER.

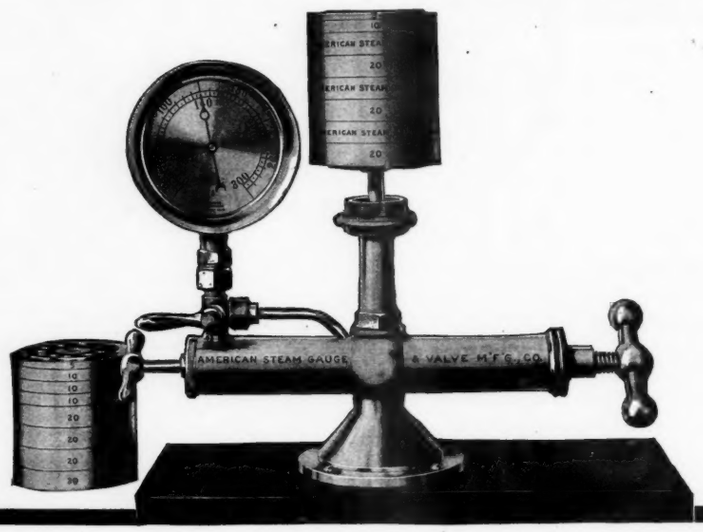
STEAM ENGINEER, experienced with slide valve and Corliss engines; I own my indicator; have I. C. S. diploma; will do my firing in small place; references given from present place. Roy C. Smith, St. Elmo, Ill.

CHIEF ENGINEER—Years of experience with high-pressure superheated steam, steam turbines; experience in erection of steam plants; as to salary try me first, if I don't make good, don't pay. Box 392, POWER.

FIRST-CLASS licensed engineer will be open for engagement after April 1; has had twenty years of power-plant experience, steam, electric and hydraulic; would be willing to take charge of estate; bond furnished if required. Address Addup, Box 398, POWER.

MECHANICAL SUPERINTENDENT, 20 years' experience in textile manufacturing, cotton goods, print works, dye works and bleaching; capable of taking full charge of mechanical and electrical departments, also construction. Box 390, POWER.

Make Sure That Your Gauges Are Not Misleading You



American Dead Weight Gauge Tester

Keep the gauges absolutely accurate and you'll be sure that your firing is being done as it should be —

You'll be sure that the pressure indications on the gauge dial are actual facts and not near-facts. The American Dead Weight Gauge Test is the sure way of testing gauge accuracy.

It tests by dead weights and shows instantly whether the gauges are keeping you correctly informed of the real pressures carried on the boilers.

It is substantially constructed, lasts a long time, has all the advantages of the mercury column inclosed in much smaller space. It takes doubt out of the boiler room. Investigate—a request brings full details of this and our other steam specialties.

American Steam Gauge & Valve Mfg. Co.

Boston, Mass.

New York, 26 Cortlandt St. **Atlanta, 525 Candler Bldg.** **Chicago, 130-132 Jefferson St.**
Pittsburg, Columbia Bank Bldg. **San Francisco, Monadnock Bldg.** **Montreal, 444 St. James St.**
Los Angeles, 213 So. Los Angeles St.

The Engineer with an American-Thompson Indicator is always sure of a job

He can always prove to his employer that his end of the business is being run as it should be—with greatest efficiency, at least operating cost.

There are no steam leaks in the cylinder of his engine, no leaky valves or piston; the valves are always properly adjusted; no power is being wasted.

He is sure of a job because he can show at any time that every dollar spent in his department is yielding a dollar's worth of results.

He can show that he is complete master of his engine, the invisible parts as well as the visible. His operating costs are low simply because he is using steam wastelessly.

And with a record like that before the boss, his job is safe for as long as he wants to hold it. When he applies for a new job, the mere fact that he owns an American-Thompson is a sign of ability—which gives him preference over any engineer who does not use an accurate indicator.

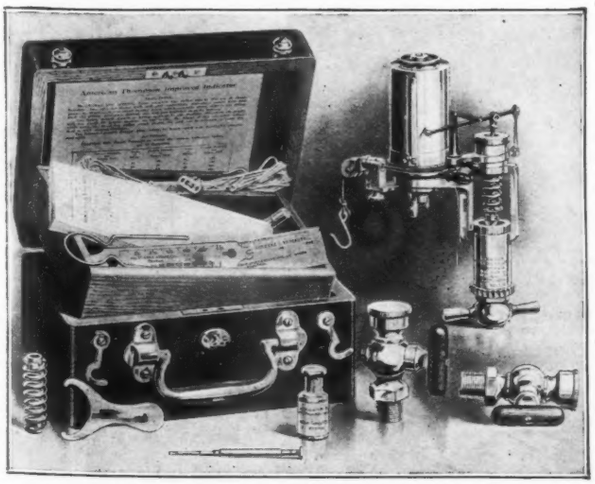
Furthermore, he is safeguarded against the Central Station idea, because, by helping him produce power economically, it enables him at all times to show operating-cost figures that will be better than Central Station figures.

Every progressive engineer should own an American-Thompson Indicator. It is the standard indicator of the world, the only original J. W. Thompson indicator, as accurate after years of work as the first day you use it.

It's the biggest help an engineer could have, not only enabling him to make good in his present position but helping him secure advancement as well.

You can buy this Quality indicator on terms that are easily within your means. $5.00 down brings it to you, $5.00 monthly pays the balance. The complete price as shown is $55.

$5.00 down—$5.00 monthly



Send the first payment today with suitable reference and we'll start an American-Thompson right off on its way to you. We extend to you the privilege of examining the outfit for a period of five days and we have never had one single outfit returned to us. This right is allowed to every purchaser.

Don't put this matter off any longer—act today—NOW.

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of your Indicator Offer No. 101.

Name . . . . . .

Address . . . . . .

City and State . . . . . .

SITUATIONS WANTED

WANTED—Position, manager or superintendent of light and power plant, erection, maintenance and operation, either of steam or gas driven plants; is thoroughly familiar technically and practically, with line work, inside wiring, operation of motors; best of references furnished; now open. Box 397, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Second-hand belt 24" to 30" by 90'. Edgerton Electric Lighting System, Edgerton, Ohio.

ANY STEAM ENGINE BUILDER thinking it time to build gas engines, should write for startling information. Box 371, POWER.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

PATENTS—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make investigations and report if patent can be had and exact cost.

ENGINEER AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

ELECTRICAL ENGINEERING—An opportunity to learn above trade at specially low rates; by entirely new methods we have prepared a course of instruction for $10 only, easy payments; at any rate, see what we have to say before paying more. P. O. Box 811, Cincinnati, Ohio.

WE WANT the agency of American manufacturers of goods that are required by machinists and engineers; we are importers of American engineering specialties and manufacturers' sole agents for Austria, Hungary and Balkan states, and have ample show rooms and offices. John Kollin & Co., General Office, Budapest, Hungary.

POWER PLANT engineers and mechanics everywhere will be paid liberally for information, strictly confidential, on improvements requiring new chimney, to assist us securing contract; we do the rest and you make some easy money. Address Construction Co., 1307 Manhattan Bldg., Chicago, Ill.

DIRECT-CONNECTED GENERATORS: 75 kilowatts, 220 volts to Ideal engine; 350-kilowatt alternator to compound engine; belted generators, 85 kilowatts 110 volts, 175 kilowatts 240-volt alternator, 225 kilowatts 220 volt; boilers, 50 to 500 horsepower; Corliss engines, 16x42, 22x42, 26x42, 19x38x48 cross compound, other engines; 45-horsepower Fairbanks-Morse gas engine, 1500-horsepower open heater. Hugh W. Dyar, 204 Dearborn St., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—Electric light plant in growing Nebraska town, pumping city water, new 20-year franchise and street-lighting contract. Box 381, POWER.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Wetherill compound condensing Corliss engine, 3000 horsepower, with General Electric generator, alternating current, 2000 kilowatts; good for 50 per cent. overload; first-class condition. Robt. Wetherill & Co., Inc., Chester, Penn.

FOR SALE—One seven-ton Chambersburg double-frame steam hammer, complete with one extra cylinder, two extra pistons and piston rods; cylinder 26 inches diameter, 6-foot stroke; anvil block 6 feet square at base; price $4000 cash; purchaser pays freight. Address "W. D. P.," Care POWER.

FOR SALE—32-horsepower and 14-horsepower Backus gas engines, line shaft and other equipment, Bliss No. 30½ combination back geared and direct drive punch press; all of the above machines in the best of condition; can be seen at any time. Ellis Adding Typewriter Co., 204 Morris Ave., Newark, N. J.

FOR SALE—135-kilowatt Fort Wayne generator, direct connected to Ide engine; 200-horsepower Heine boiler; 150-horsepower return tubular boiler; several large size American Blower Company force draft fans and feed-water regulator; all in first class condition. Address Textile Machine Works, Reading, Penn.

SECOND-HAND gas engines for sale: One 75-horsepower Pierce-Crouch; one 60-horsepower Pierce-Crouch; two 50-horsepower Pierce-Crouch; one 35-horsepower Pierce-Crouch; one 3-horsepower Pierce-Crouch; one 35-horsepower Otto; one 35-horsepower Fenner; one 45-horsepower, two-cylinder Walrath; one 85-horsepower, three-cylinder Walrath. All for sale cheap to quick buyer. Hazel-Atlas Glass Co., Wheeling, W. Va.

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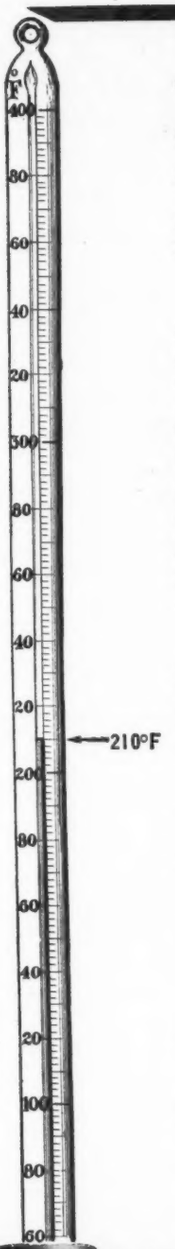
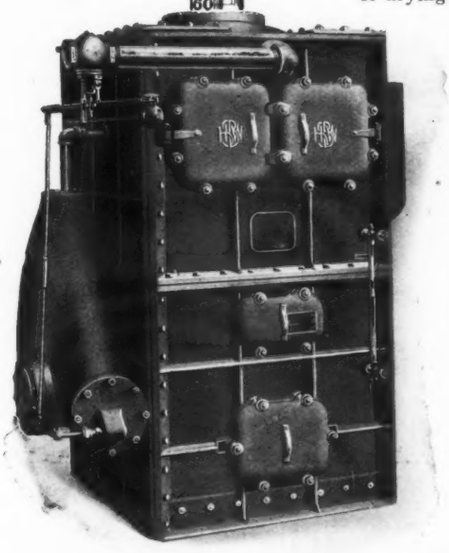




To Obtain One Of These High-Class Engineers' Thermometers

1. **Give the name of the plant in which you are operating engineer.**
2. **The make and kind of feed water heater now in use.**
3. **Enclose ONE DOLLAR in stamps, bill, check or money order.**

The Cochrane Engineers' Thermometer is a high-grade instrument, which could not be bought in the open market for anything like the price named. It is fitted with a nickel-plated metal carrying case, chain and safety pin, and has been especially designed for the use of stationary engineers in measuring the temperature of boiler feed water, the temperature of steam in the condenser, the temperature of the hot well water from the condenser, the temperature of steam in a throttling calorimeter, the temperature of lubricating oil, the temperature of circulating water in heating systems, etc., etc.

It will enable you to discover whether or not you are operating your plant at the highest efficiency. **IF THE TEMPERATURE OF YOUR BOILER FEED WATER IS BELOW 210° F., YOU ARE LOSING MONEY THAT YOU MAY BE ABLE TO SAVE.** Every 10° F. added to the temperature of the feed water represents 1 per cent of the fuel bill saved.

The important question is how many per cent of the fuel bill are you now losing that could easily be saved? With a **COCHRANE HEATER** installed, and supplied with the proper amount of exhaust steam, the temperature of the feed water would at all times be 210° F., or higher where back pressure is carried.

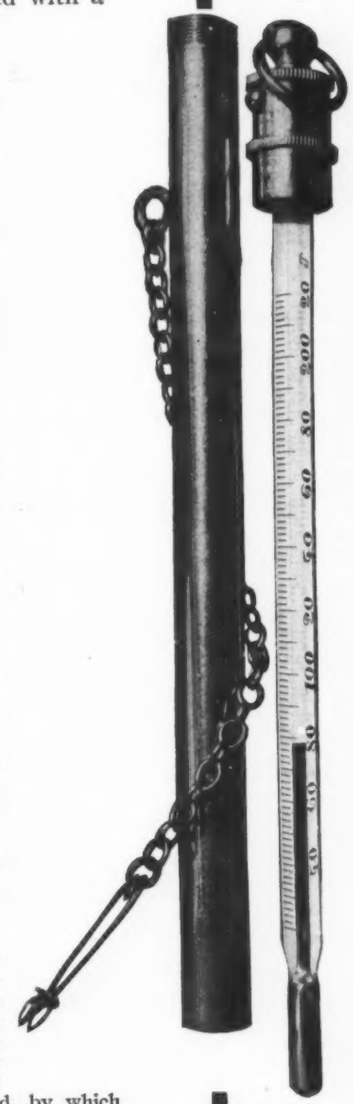
The heating of the water to 210° F. by spraying it through the steam bath of a Cochrane Heater drives off air and gases, which are the more general causes of corrosion.

The driving off of carbon dioxide gas changes the soluble bicarbonates into the insoluble monocarbonates, which precipitate out in the heater.

If the water also contains permanent hardness, that is, sulphates, chlorides, nitrates, etc., the **SORGE-COCHRANE HOT PROCESS SYSTEM** will protect the boilers from scale and corrosion, while at the same time giving all the benefits of a Cochrane Open Feed Water Heater.

If you are about to install an exhaust steam heating or drying system, the new Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver will save from $50 to $500 on the cost of equipment.

Most people can bear their hands in water heated to 120° F., and some can go a little higher, but no one can hold his hand in water as hot as it ought to be when it enters the boilers. Send the information specified, together with the **DOLLAR,** and we shall be pleased to send you a thermometer, charges prepaid, by which you can settle these matters definitely. Then you will also receive free a copy of our book on the *"Profitable Utilization of Exhaust Steam,"* in which matters relating to the temperature of steam and feed water, etc., are explained at length.



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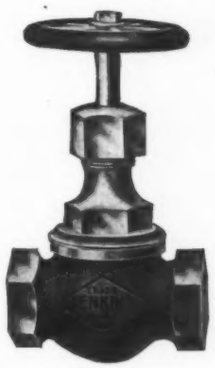

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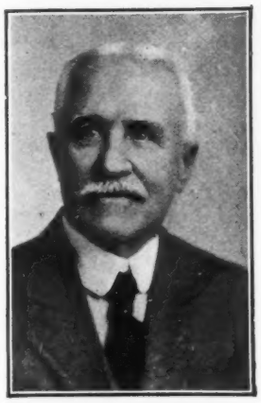
The "Eureka" Square Deal

Published every other week in the Interests of Honesty in the Packing Business.

Vol. I. **By James L. Robertson.** No. IV

What Inspired This "Graft" Campaign?



JAMES L. ROBERTSON

Many of you who have been reading The Eureka Square Deal may have wondered why I'm buying the space and taking the time to talk "graft." This is the reason:

For years, Eureka Packing has held a place second to none as a packing.

It holds that position today.

But I have found Eureka being replaced in some plants with packings that are palpably inferior imitations, and others that I *know* have been put there because graft went with them.

HOW EUREKA IS PACKED

Eureka, like every other packing, has been replaced in some places by fair competition—I'm talking about something entirely different.

Now, when I find a condition of this kind existing I do not believe in letting it continue without a kick. I have a fair share of fighting blood and I do not intend to see my honestly made, honestly sold packing knifed in the back by some denizen of the packing underworld.

This suave gentleman or one of his salesmen disguises his "gifts" under a cloud of high-sounding and plausible arguments. But the ugly truth shows in spots—they are "grafters," pure and simple.

Their purpose is to sell engineers a generally inferior packing, offer him a bribe with it and thus bind the buyer to them hand and foot.

They are out for all they can get and *they'll get it out of the buyer* as sure as time, tide and taxes.

Now, if I wanted to, I could fight these gentlemen with their own weapons. But it has always seemed to me that there is a heap more satisfaction and honor in doing business with fair and square people on a fair and square basis. It is my belief, based on knowledge, that there is no more honorable class of men than engineers. It seems shameful that a minority should be allowed to put any stigma on the others. I am not the only packing maker doing business on a square basis. There are other "straight" folks making packing and if their packing beats "Eureka" in a fair trial they deserve your patronage.

My claim—and this is borne out by long experience—is that Eureka Packing, for all pressures up to 125 lbs., renders better all-around service than any other kind.

A trial of it will prove my claim. Ask your dealer to supply you, *and see that you get genuine Eureka.*

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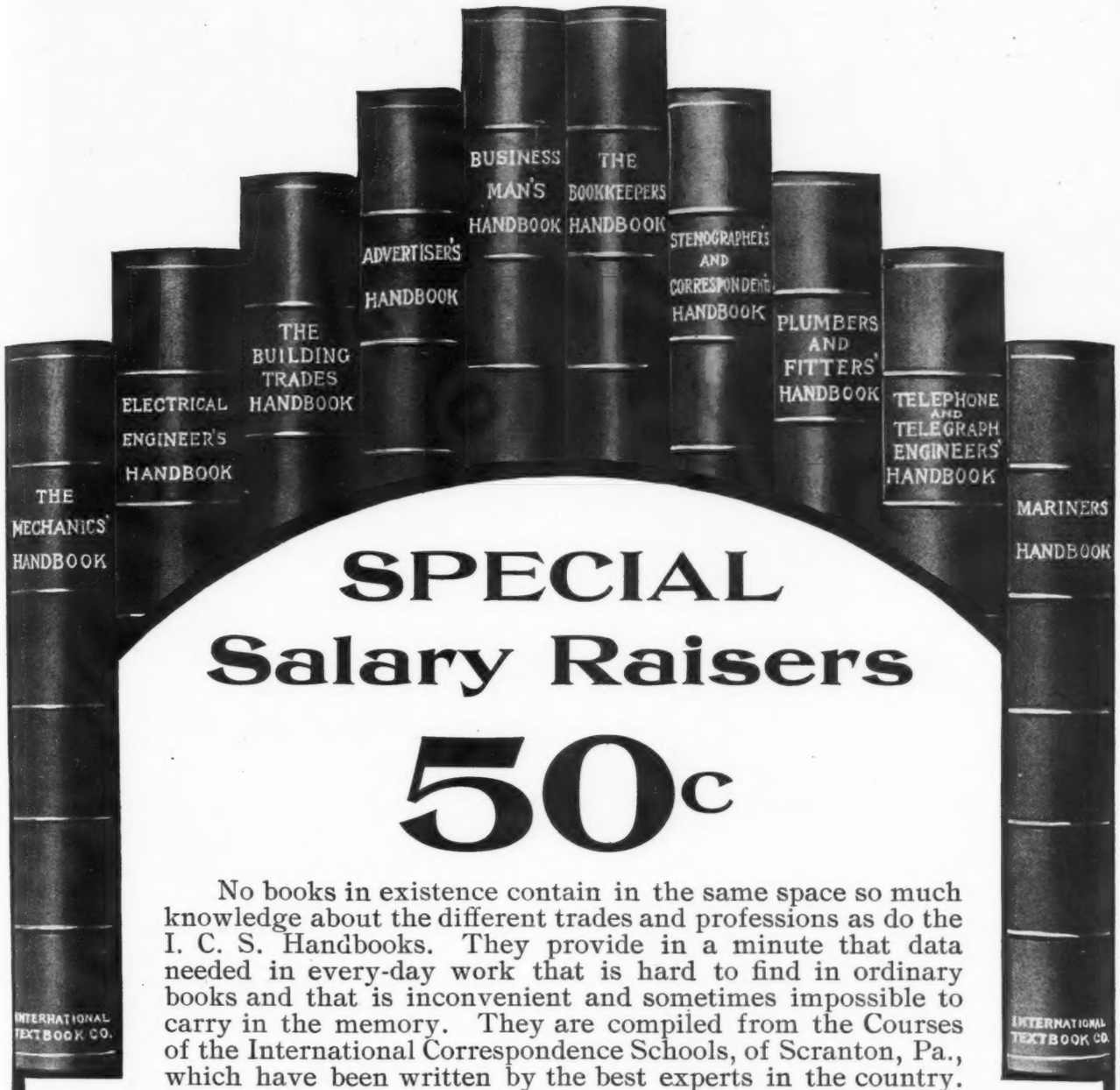

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